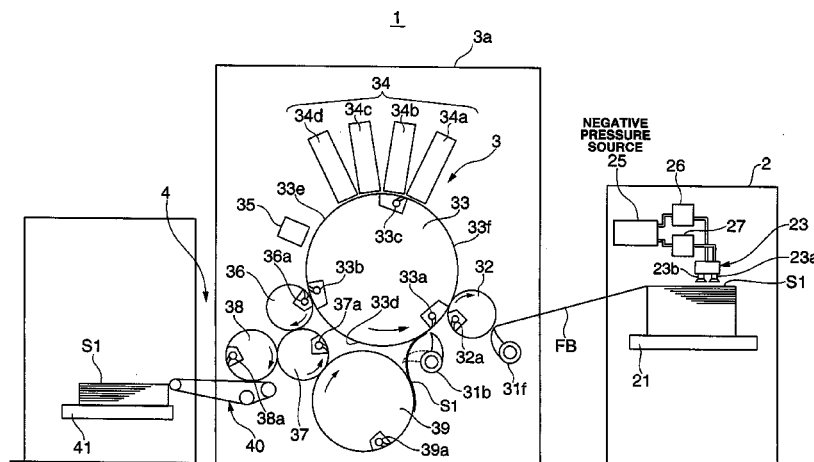


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8 Claims, 13 Drawing Sheets



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B65H 5/12 (2006.01)
- (52) **U.S. Cl.**
CPC *B65H 2557/242* (2013.01); *B65H 2801/15*
(2013.01)
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FIG. 1

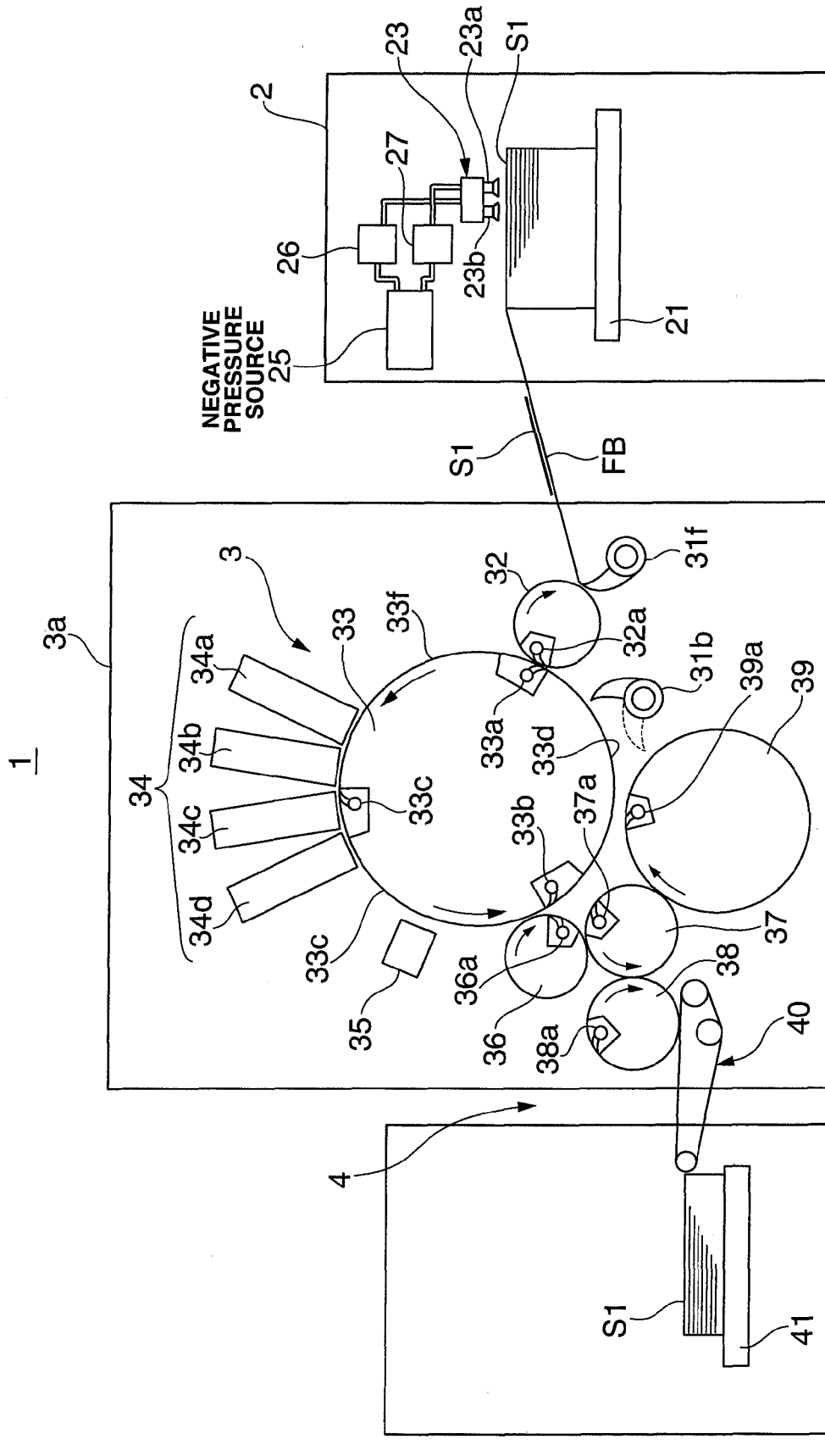


FIG.2

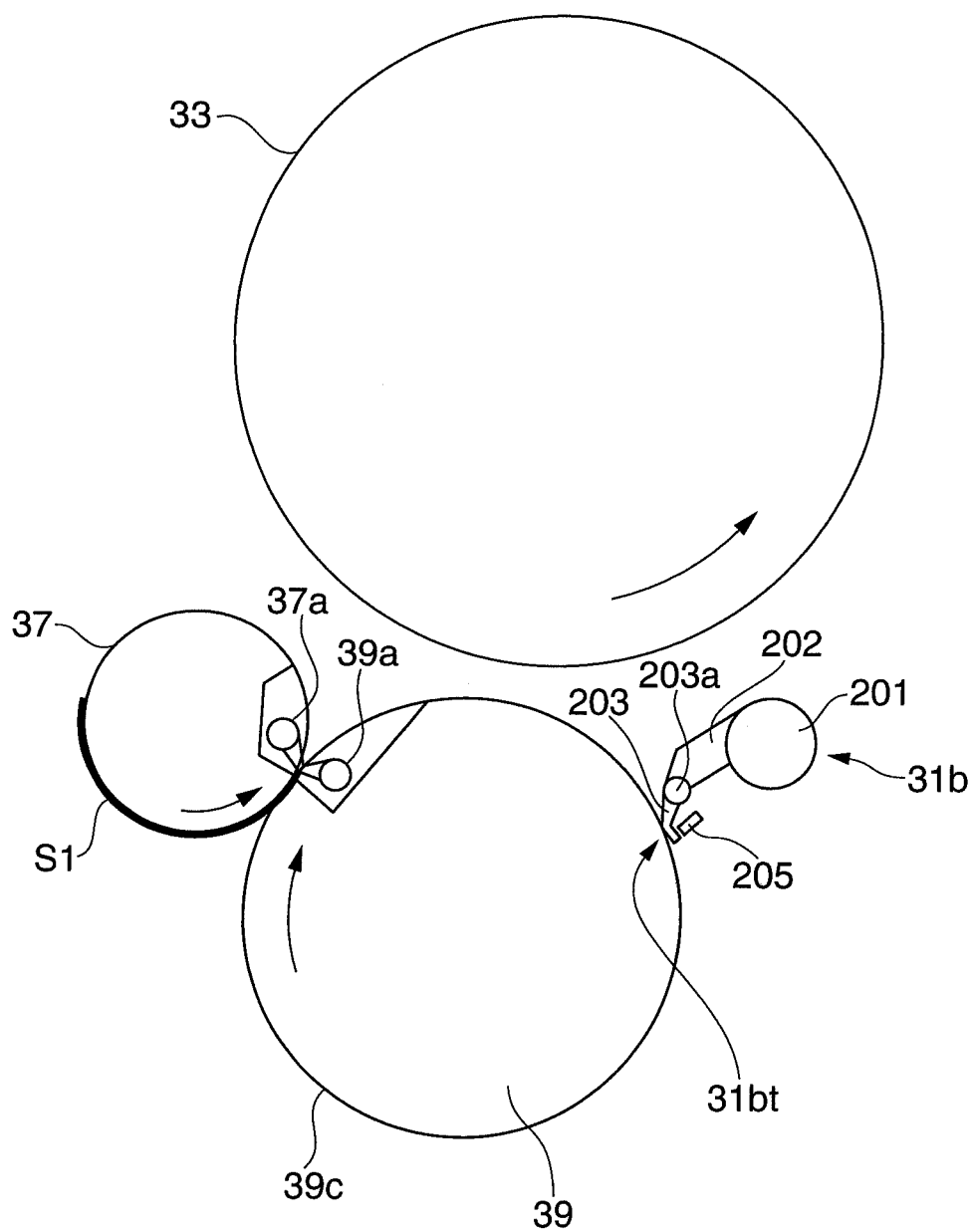


FIG. 3

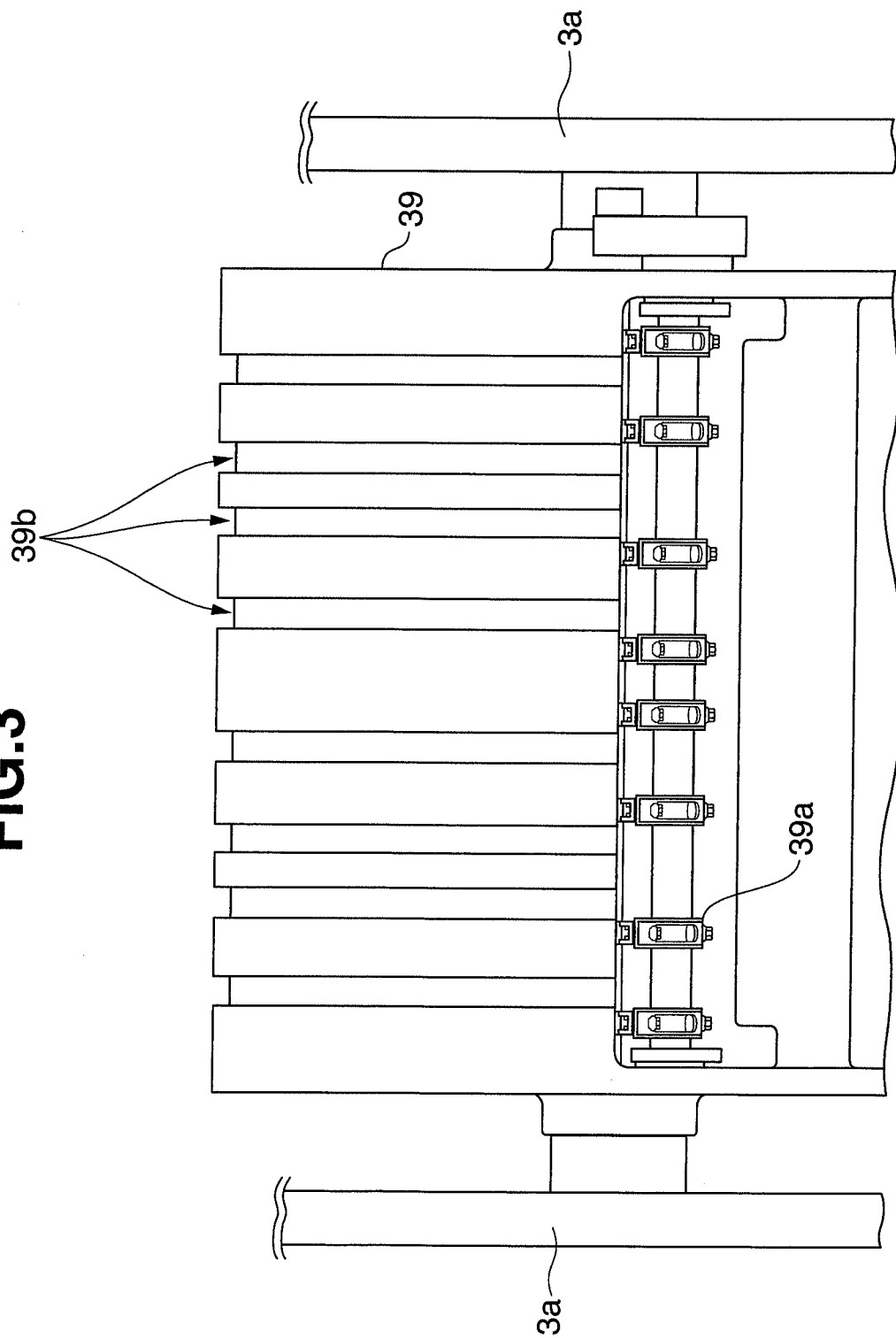


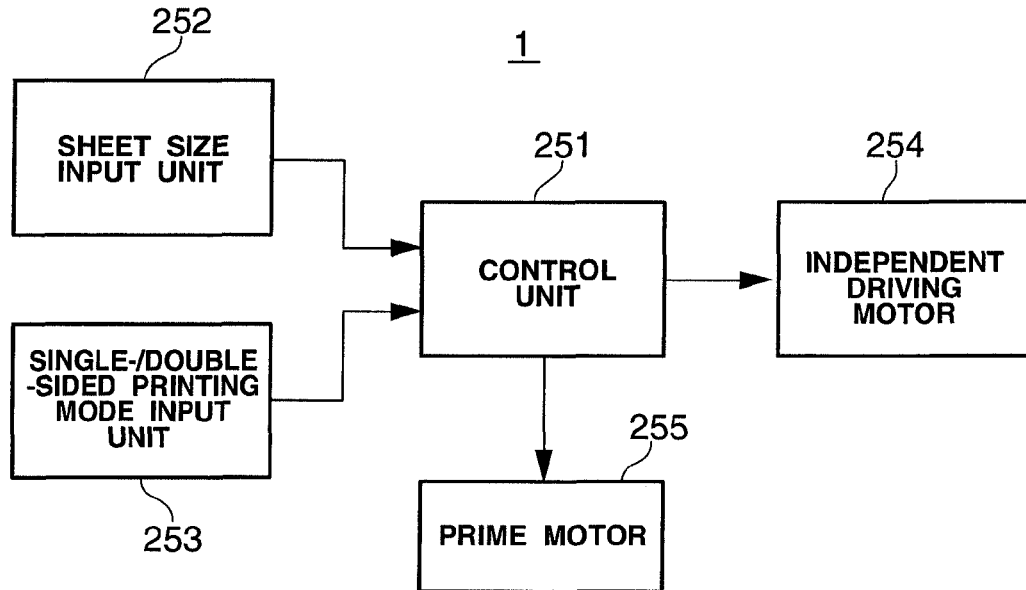
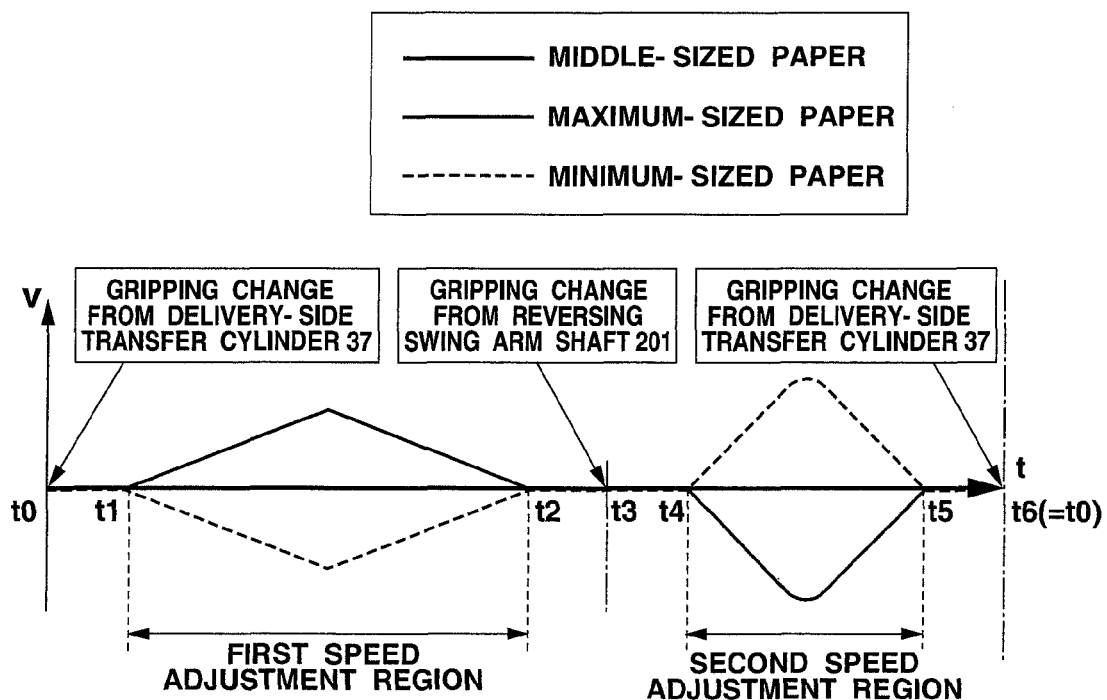
FIG.4**FIG.6**

FIG. 5A

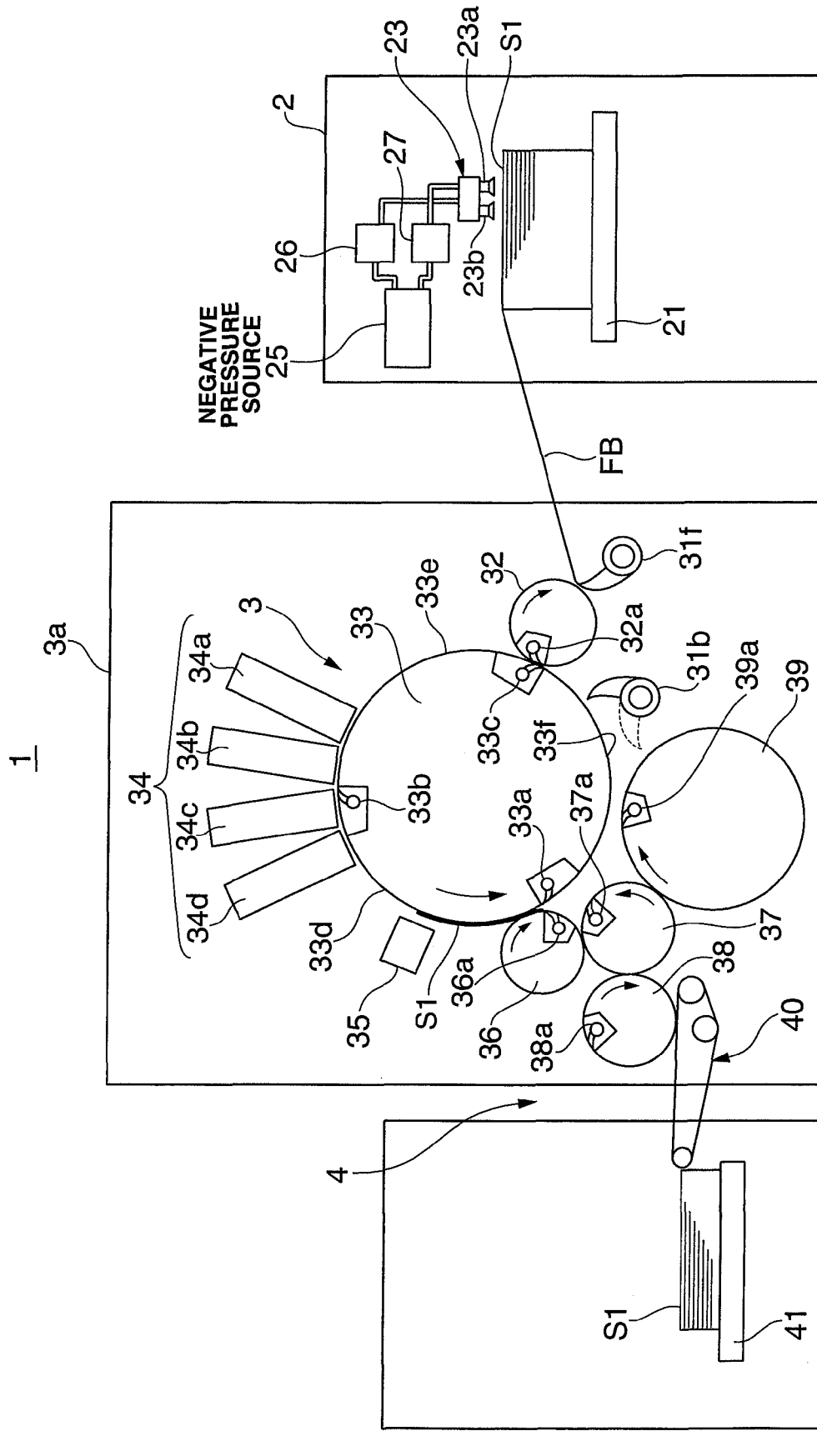


FIG. 5B

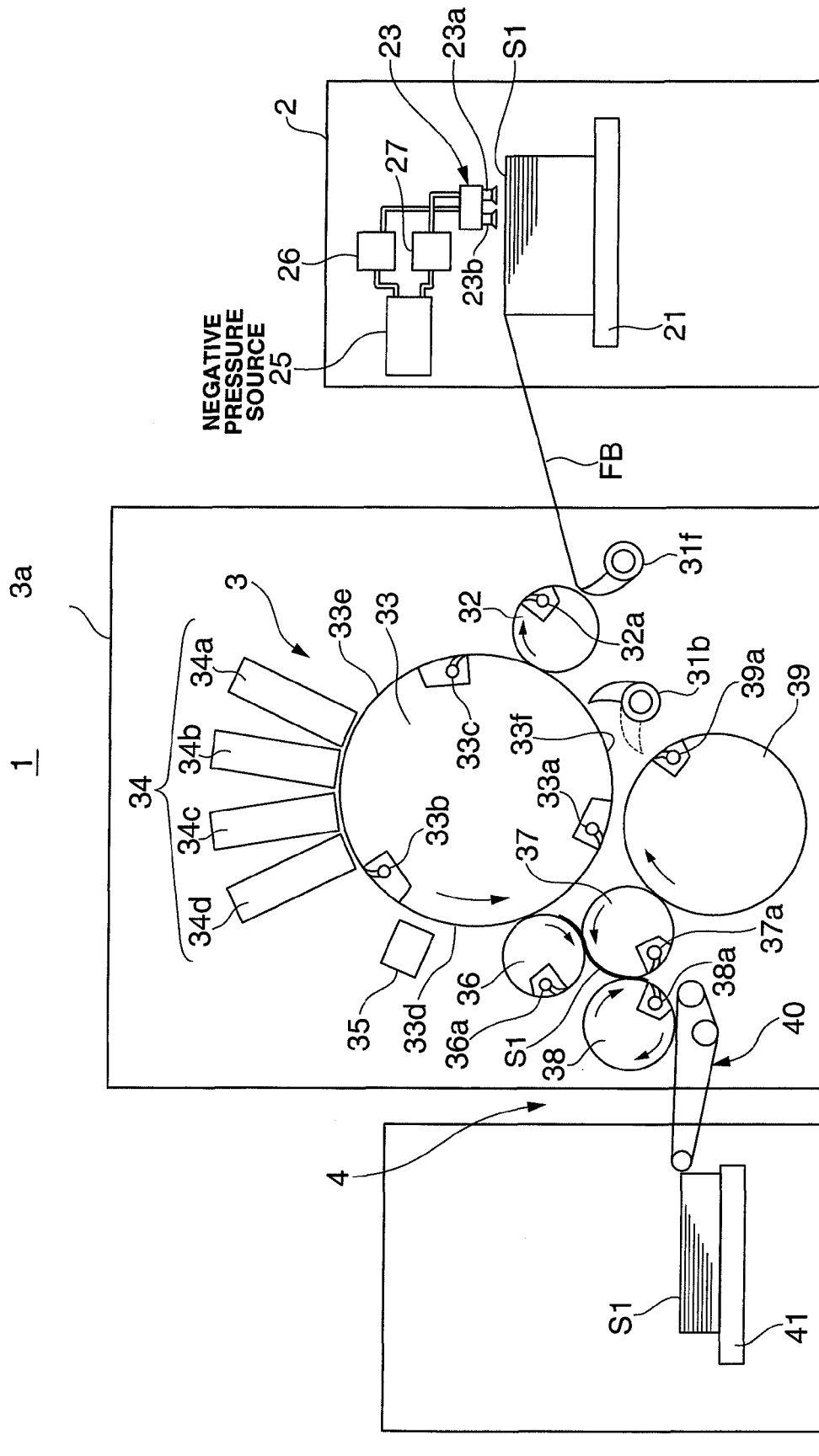


FIG. 5C

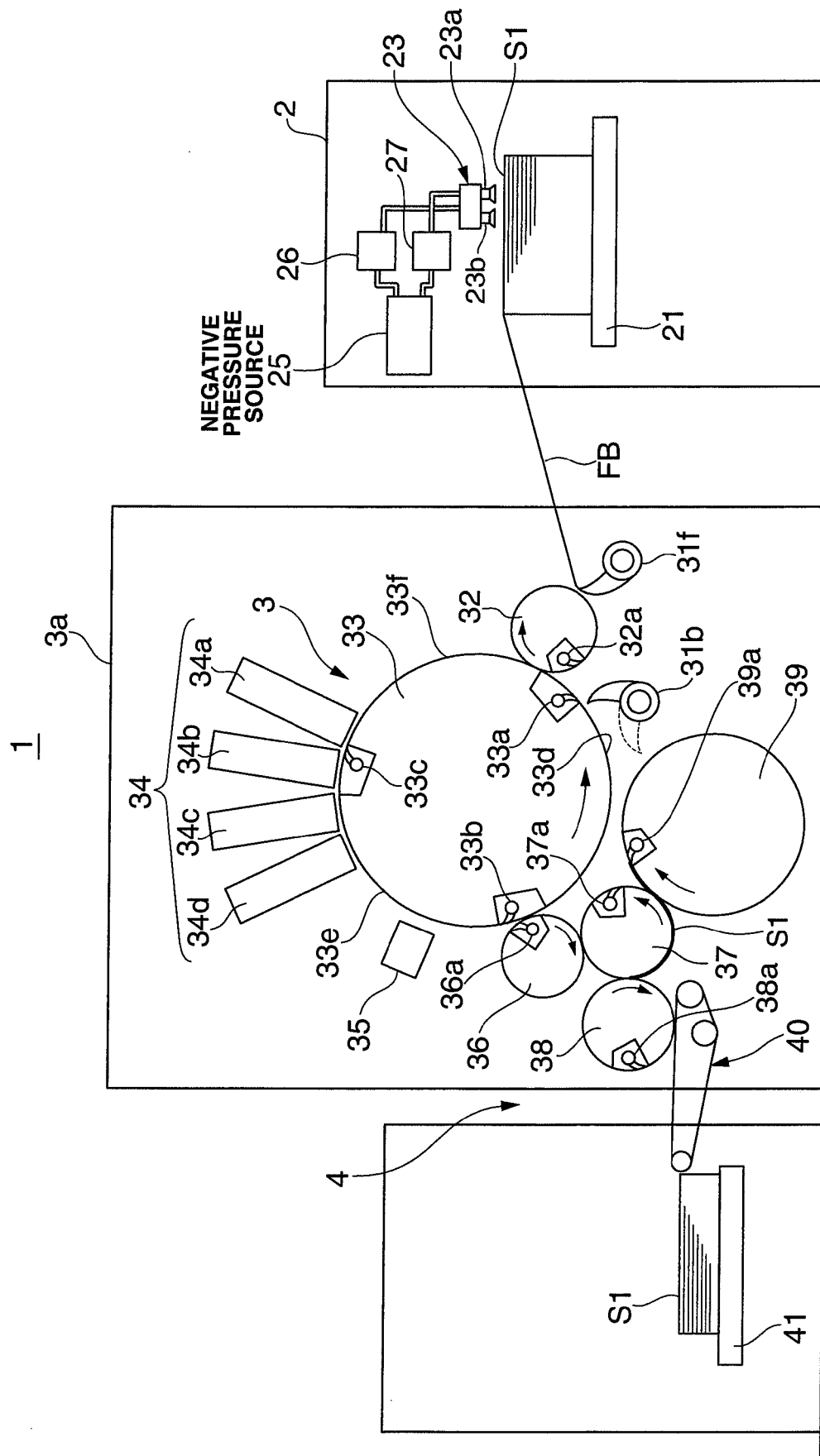


FIG. 5D

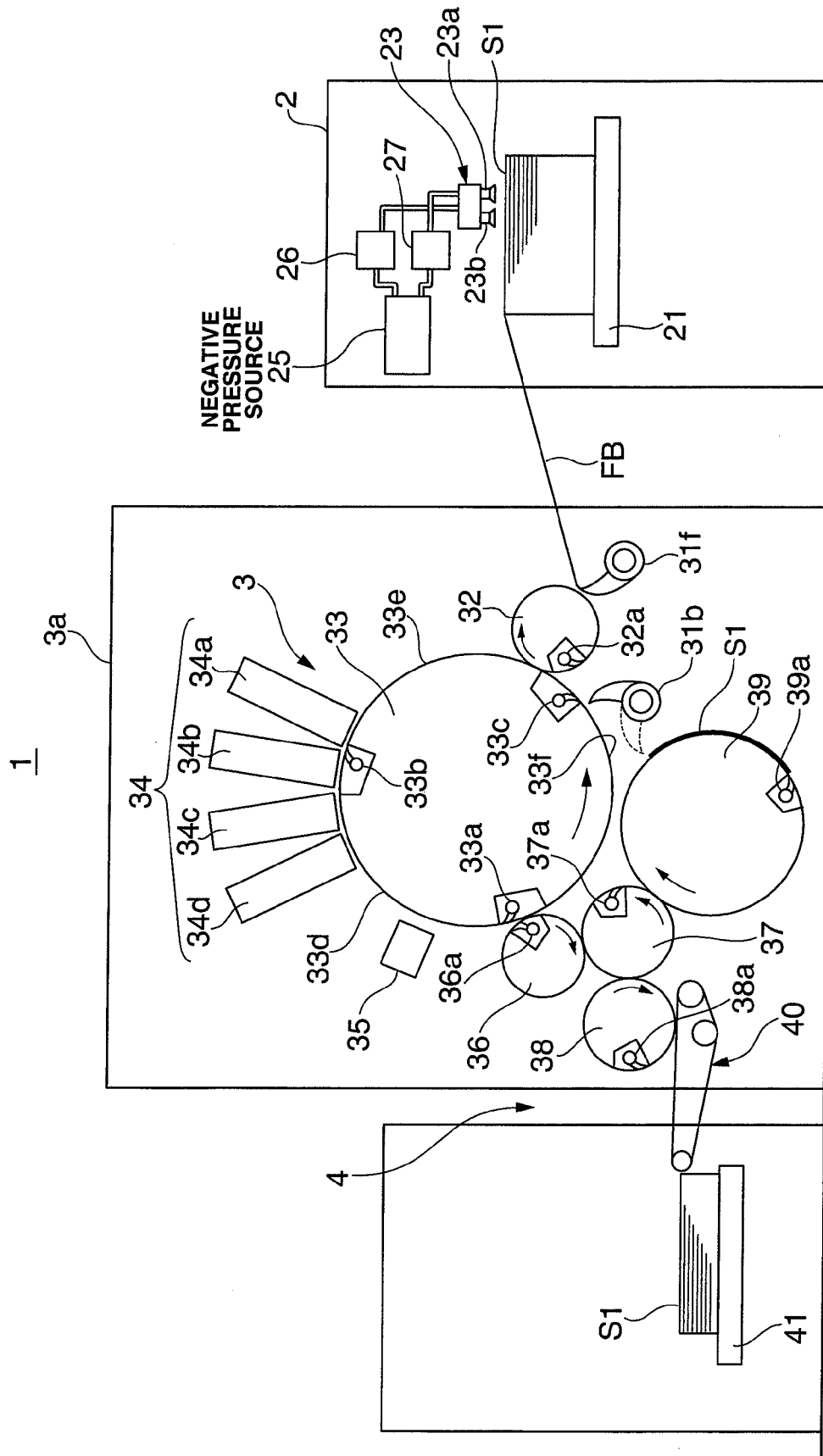


FIG. 5E

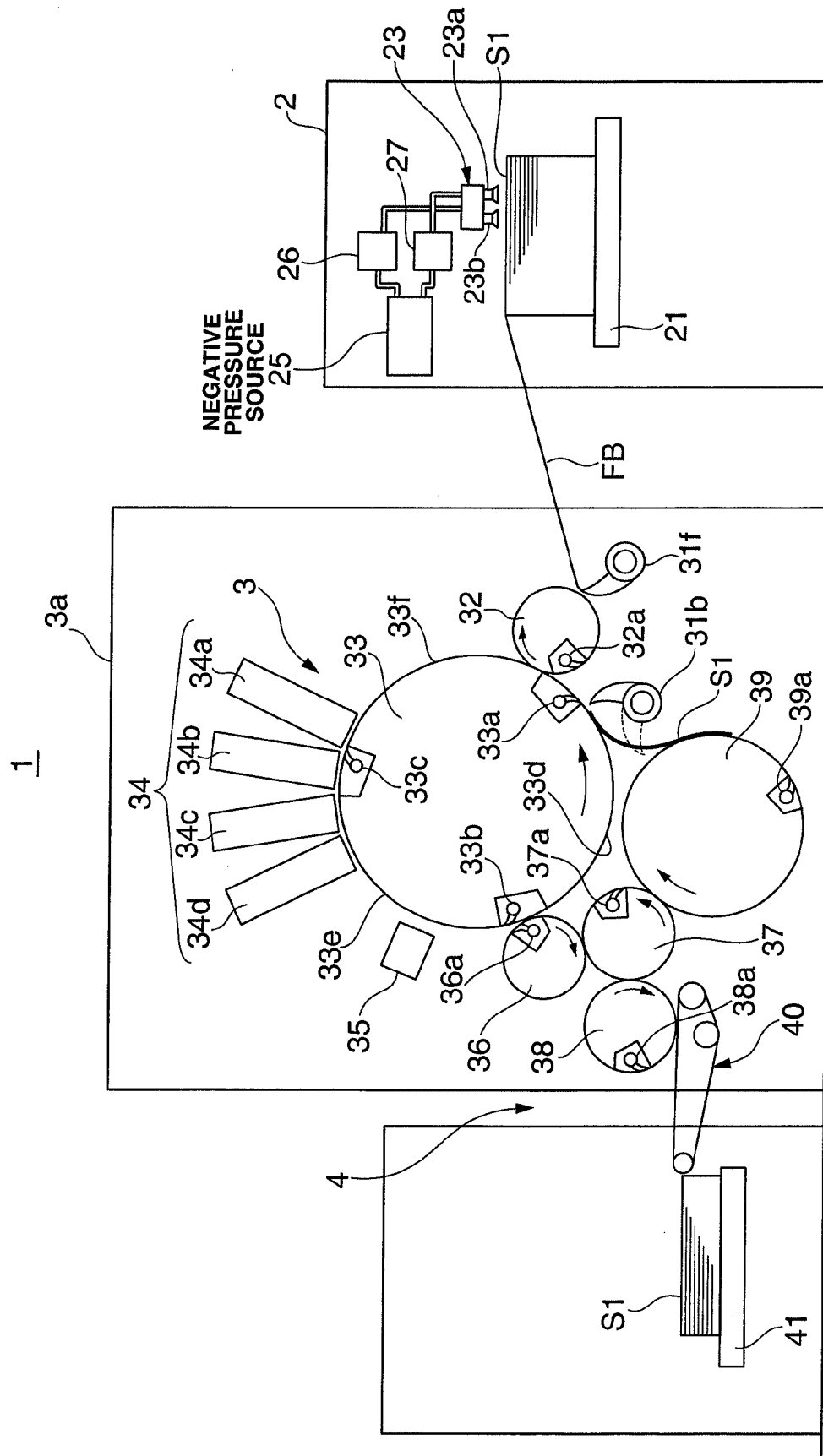


FIG. 7

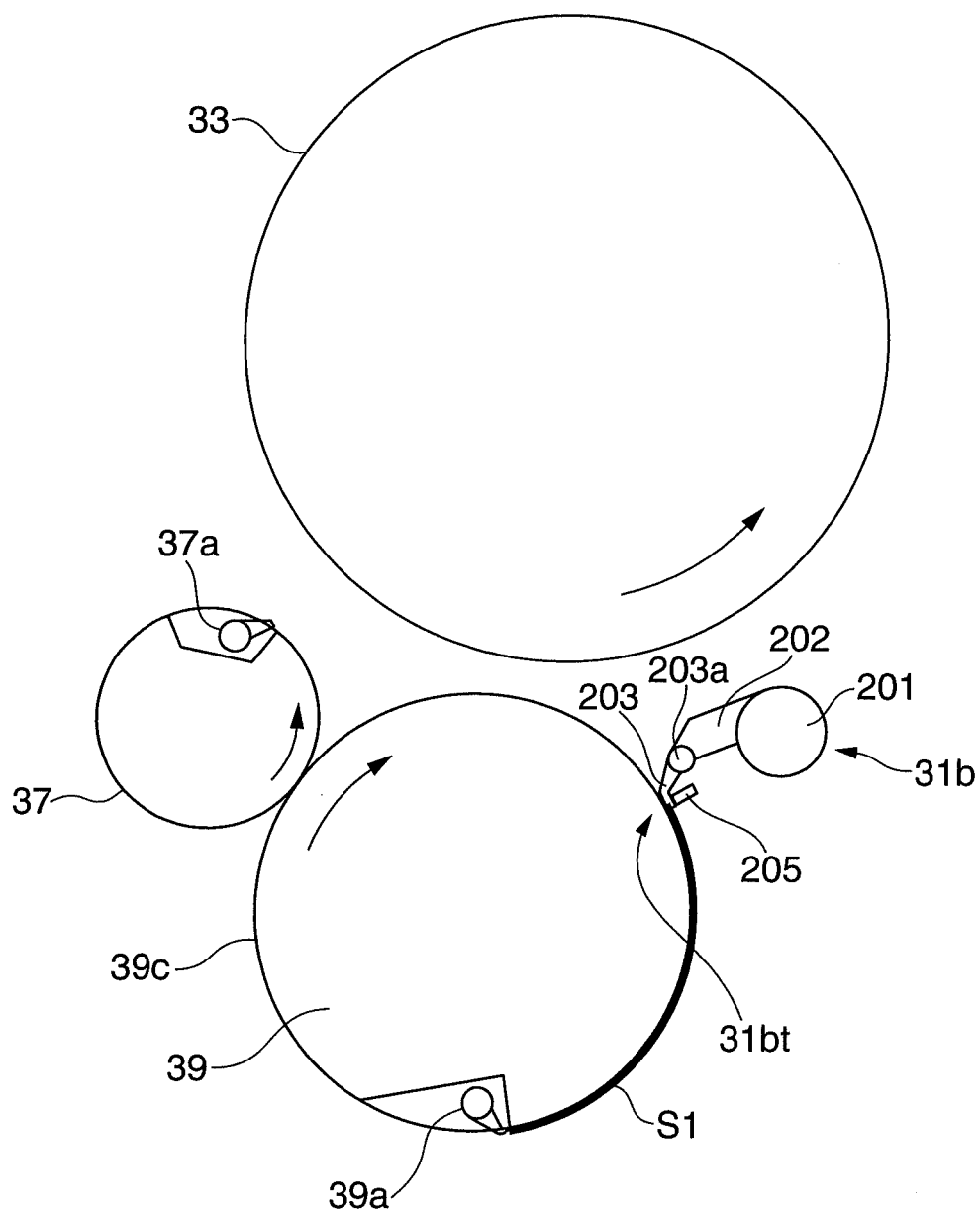


FIG. 8

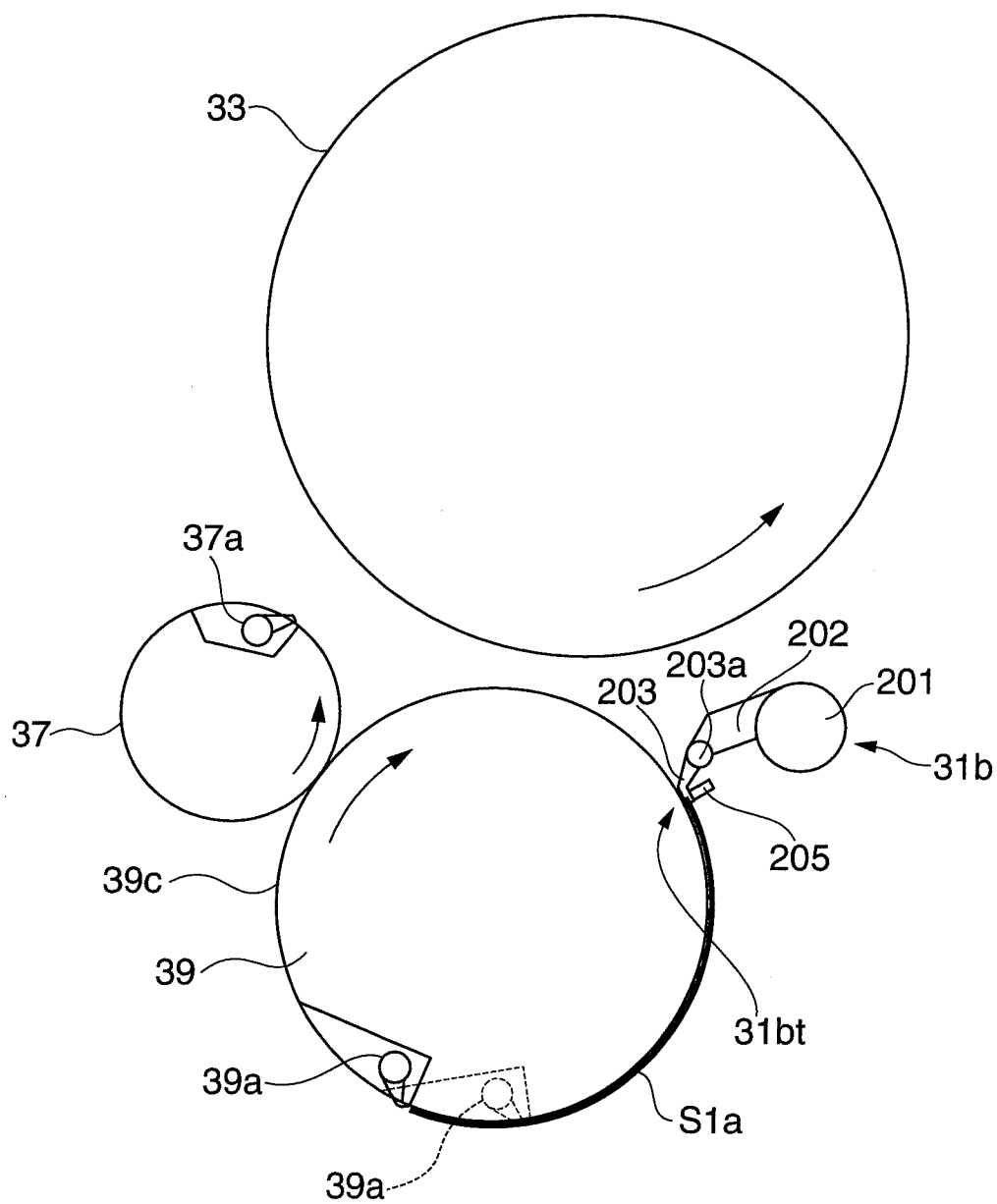


FIG. 9

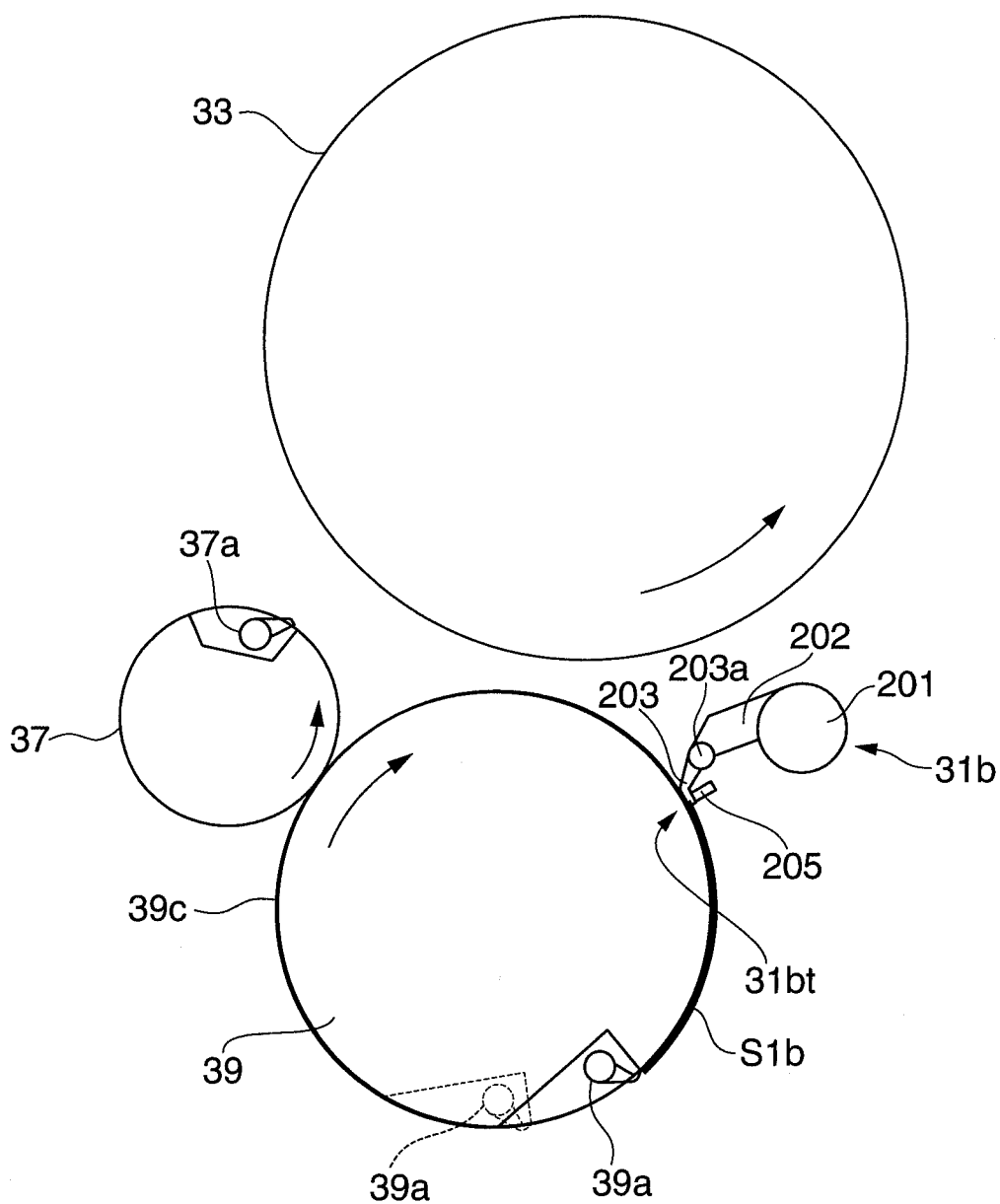
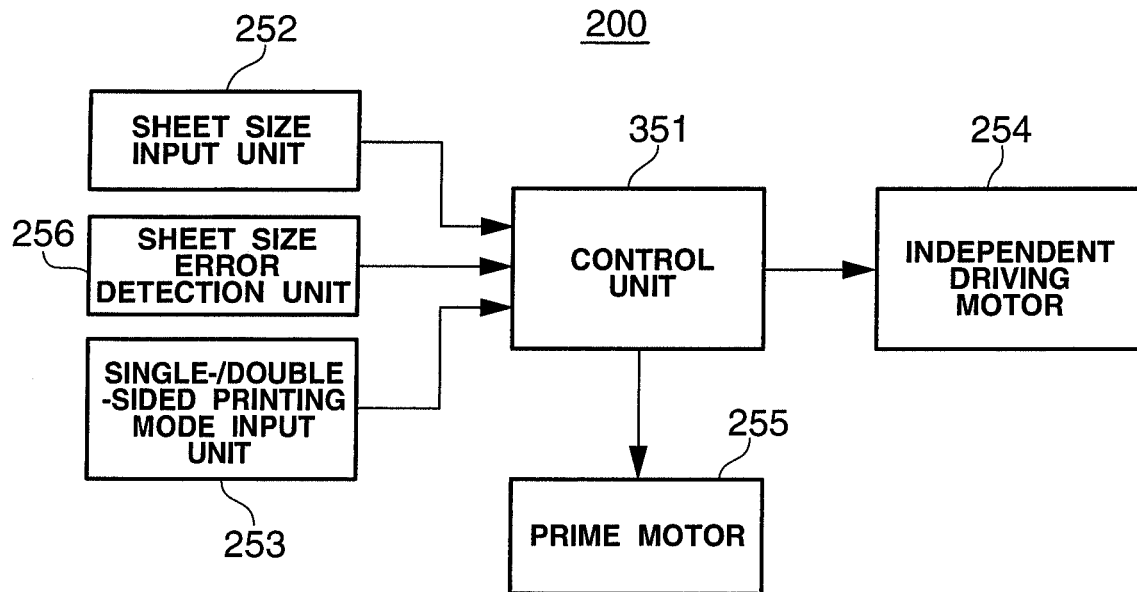
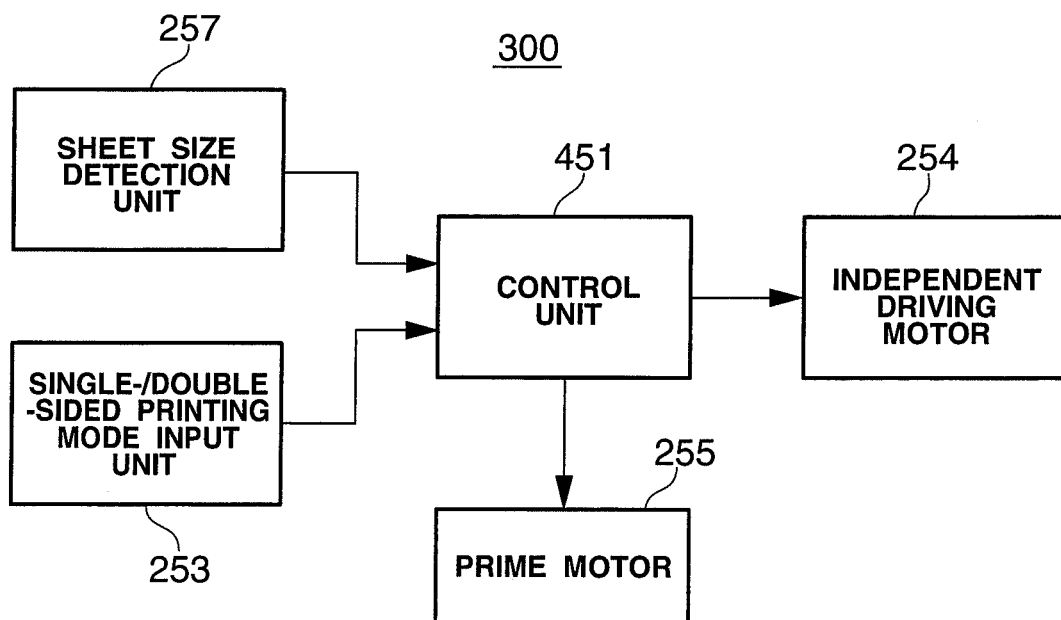


FIG.10**FIG.11**

SHEET CONVEYANCE DEVICE

BACKGROUND OF THE INVENTION

The present invention relates to a sheet conveyance device which conveys a sheet.

Conventionally, as a sheet conveyance device which conveys a sheet, a sheet conveyance device which includes a sheet reversing unit and is applied to a sheet-fed offset rotary printing press equipped with a reversing mechanism and capable of printing on one or both of the two surfaces of a sheet, has been proposed, as described in Japanese Patent Laid-Open No. 58-219058 (literature 1). In the printing press proposed in literature 1, a sheet conveyance device including a reversing unit is interposed between first and second, adjacent printing units, and performs a selective reversing operation for a sheet conveyed by the sheet conveyance device to allow single-sided printing and double-sided printing on the sheet.

In the printing press described in literature 1, the reversing unit includes a transfer cylinder (reference numeral 17) and impression cylinder (reference numeral 16). In double-sided printing, the trailing edge of a sheet conveyed while the leading edge of the sheet is gripped by the transfer cylinder is gripped by the impression cylinder to convey the sheet with its trailing edge leading, and turn it.

However, in the printing press described in literature 1, when the sheet size is changed, engagement of a gear which drives the impression cylinder is canceled before activation of the printing press, the phase of the impression cylinder relative to the transfer cylinder is changed so that a gripper device of the impression cylinder is opposed to the trailing edge of the sheet held on the transfer cylinder, and then the gear must be engaged again. This increases the operator's burden, and its preparation takes a considerable time.

SUMMARY OF THE INVENTION

It is an object of the present invention to propose a sheet conveyance device which can easily cope with a change in size of a sheet.

In order to achieve the above-mentioned object, according to the present invention, there is provided a sheet conveyance device comprising a first conveyance unit which includes a first holder that holds one edge of a sheet, and conveys the sheet held by the first holder, a second conveyance unit which includes a second holder that holds the one edge of the sheet, and conveys the sheet held by the second holder, a third conveyance unit which is supported to be swingable between a reception position at which the third conveyance unit receives the sheet from the first conveyance unit, and a transfer position at which the third conveyance unit transfers the sheet to the second conveyance unit, the third conveyance unit including a third holder that holds the other edge of the sheet conveyed by the first conveyance unit, and conveying the sheet held by the third holder, an independent driving unit which independently drives the first conveyance unit, a device driving unit which drives an entire device including the second conveyance unit and the third conveyance unit, and a control unit which controls the independent driving unit to adjust a speed at which the third conveyance unit conveys the sheet, based on a dimension of the sheet in a conveyance direction.

According to an aspect of the present invention, even if the sheet size is changed, driving of the first conveyance unit (39) is controlled through the independent driving unit (254) based on the changed dimension of the sheet in the conveyance

direction. With this operation, the trailing edge of the sheet with its size changed can be held by the third holder (31b) of the third conveyance unit (31b) which swings at a predetermined period.

According to another aspect of the present invention, when the trailing edge of the sheet conveyed by the transport cylinder (39) is held by the third holder (31b) of the third conveyance unit (31b), the speed of the transport cylinder (39) is adjusted so that the third holder (31b) of the third conveyance unit (31b) which swings at a predetermined period is opposed to the trailing edge of the sheet at the reception position. With this operation, even if the sheet size is changed, the trailing edge of the sheet can reliably be transferred from the transport cylinder (39) to the third conveyance unit (31b). Also, the speed of the transport cylinder (39) is adjusted so that the fourth holder (37a) of the fourth conveyance unit (37) is opposed to the first holder (39a) of the transport cylinder (39) after the sheet is held by the third holder (31b). With this operation, the leading edge of the next new sheet can reliably be transferred from the fourth conveyance unit (37) to the first conveyance unit (39).

According to still another aspect of the present invention, if the dimension of the sheet in the conveyance direction is larger than a standard size (reference size), the rotation speed of the transport cylinder (39) is controlled to be higher than the reference speed after the sheet is received from the fourth conveyance unit (37), and lower than the reference speed after the sheet is transferred from the transport cylinder (39) to the third conveyance unit (31b). With this operation, even if the dimension of the sheet in the conveyance direction is large, the leading edge of the next new sheet conveyed from the fourth conveyance unit (37) can reliably be held by the transport cylinder (39) after the trailing edge of the sheet is reliably held while the transport cylinder follows a motion of the third conveyance unit (31b). However, if the dimension of the sheet in the conveyance direction is smaller than the standard size, the rotation speed of the transport cylinder (39) is controlled to be lower than the reference speed after the sheet is received from the fourth conveyance unit (37), and higher than the reference speed after the sheet is transferred from the transport cylinder (39) to the third conveyance unit (31b). With this operation, even if the dimension of the sheet in the conveyance direction is small, the leading edge of the next new sheet conveyed from the fourth conveyance unit (37) can reliably be held by the transport cylinder (39) after the trailing edge of the sheet is reliably held while the transport cylinder follows a motion of the third conveyance unit (31b).

According to still another aspect of the present invention, when the sheet is transferred from the transport cylinder (39) to the third conveyance unit (31b), and when the sheet is received from the fourth conveyance unit (37), the transport cylinder (39) is rotated at the reference speed by the independent driving motor (254). This allows reliable reception and transfer of the sheet, regardless of the dimension of the sheet in the conveyance direction.

According to still another aspect of the present invention, if the dimension of the sheet in the conveyance direction is the standard size, the transport cylinder (39) is always rotated at a constant reference speed by the independent driving motor (254). This allows reliable reception and transfer of the sheet with the standard size.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side view showing the schematic arrangement of a digital printing apparatus according to the first embodiment of the present invention;

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FIG. 2 is a side view showing a reversing mechanism portion shown in FIG. 1;

FIG. 3 is a top view showing the circumferential surface structure of a pre-reversal double-diameter cylinder shown in FIG. 2;

FIG. 4 is a control block diagram of the digital printing apparatus shown in FIG. 1;

FIGS. 5A to 5E are side views showing double-sided printing processes (1) to (5) in the digital printing apparatus shown in FIG. 1;

FIG. 6 is a timing chart showing the speed control sequence of the pre-reversal double-diameter cylinder shown in FIG. 2;

FIG. 7 is a side view for explaining a sheet gripping change operation from the pre-reversal double-diameter cylinder to a reversing swing arm shaft pregrripper if the sheet size is a standard size;

FIG. 8 is a side view for explaining a sheet gripping change operation from the pre-reversal double-diameter cylinder to the reversing swing arm shaft pregrripper if the sheet size is larger than the standard size;

FIG. 9 is a side view for explaining a sheet gripping change operation from the pre-reversal double-diameter cylinder to the reversing swing arm shaft pregrripper if the sheet size is smaller than the standard size;

FIG. 10 is a circuit block diagram according to the second embodiment of the present invention, in which the speed of a pre-reversal double-diameter cylinder is controlled in consideration of an error of the sheet size; and

FIG. 11 is a circuit block diagram according to the third embodiment of the present invention, in which the speed of a pre-reversal double-diameter cylinder is controlled in consideration of the actual measurement value of the sheet size.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

The present invention will be described in detail below with reference to the accompanying drawings.

(1) First Embodiment

Arrangement of Digital Printing Apparatus

A digital printing apparatus 1 (sheet processing apparatus) according to this embodiment includes a sheet feed device 2 (sheet supply device), a digital printing unit 3 (processing unit), and a sheet delivery device 4 (sheet discharge device), as shown in FIG. 1.

The sheet feed device 2 includes a pile board 21 on which a plurality of sheets S1 are stacked, and a sucker device 23 which conveys the top sheet S1 on the pile board 21 onto a feeder board FB. The sucker device 23 includes a pair of suction ports 23a and 23b, which are connected to a negative pressure source 25 via a continuous supply valve 26 and an intermittent supply valve 27.

The continuous supply valve 26 and intermittent supply valve 27 enable/disable, at different timings, the suction operation of the suction ports 23a and 23b using a negative pressure from the negative pressure source 25.

A swing arm shaft pregrripper 31f is disposed on the distal end side of the feeder board FB in the sheet conveyance direction. The swing arm shaft pregrripper 31f is swingably supported on a frame 3a of the digital printing unit 3, and includes a gripper device (not shown) which grips and holds the leading edge (front edge) of the sheet S1 as its one edge. A feed-side transfer cylinder 32 is opposed to the swing arm shaft pregrripper 31f, and rotatably supported on the frame 3a.

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A gripper device 32a which holds the leading edge of the sheet S1, transferred by a gripper device of the swing arm shaft pregrripper 31f, in a gripped state is provided on the feed-side transfer cylinder 32. The swing arm shaft pregrripper 31f and feed-side transfer cylinder 32 constitute an upstream sheet conveyance device. Note that in the following description, the gripper device is formed by a plurality of grippers aligned in the cylinder axis direction with predetermined gaps between them.

A printing cylinder 33 (second conveyance unit) serving as a downstream transport cylinder is disposed on the downstream side of the swing arm shaft pregrripper 31f in the sheet conveyance direction to be in contact with the feed-side transfer cylinder 32. The printing cylinder 33 is rotatably supported on the frame 3a, and has a diameter three times that of the feed-side transfer cylinder 32. The printing cylinder 33 includes printing cylinder gripper devices 33a, 33b, and 33c (second holders) which hold the leading edge of the sheet S1 upon receiving it from the gripper device 32a of the feed-side transfer cylinder 32, and support surfaces 33d, 33e, and 33f which are provided in correspondence with the printing cylinder gripper devices 33a, 33b, and 33c, and support the sheet S1. The printing cylinder 33 is implemented by a triple-diameter cylinder provided with three pairs of printing cylinder gripper devices 33a, 33b, and 33c and support surfaces 33d, 33e, and 33f. The printing cylinder gripper devices 33a, 33b, and 33c are provided at positions 120° out of phase with each other in the circumferential direction.

An inkjet nozzle portion 34 is opposed to the circumferential surface of the printing cylinder 33 on the downstream side of the contact portion of the printing cylinder 33 with the feed-side transfer cylinder 32 in the sheet conveyance direction.

The inkjet nozzle portion 34 includes a plurality of inkjet nozzle heads 34a to 34d (to be referred to as ink heads hereinafter) which are juxtaposed in the sheet conveyance direction along the circumferential surface of the printing cylinder 33, and store inks of different colors. Each of the ink heads 34a to 34d is oriented in a direction perpendicular to the circumferential surface of the printing cylinder 33. The ink heads 34a to 34d are arranged in proximity to the printing cylinder 33 to have small gaps with the sheet S1 having its entire surface sucked by the support surfaces 33d, 33e, and 33f. The printing cylinder 33 and inkjet nozzle portion 34 constitute a sheet printing device.

An ink drying lamp 35 is opposed to the printing cylinder 33 on the downstream side of a printing region 33K, printed by the inkjet nozzle portion 34 of the printing cylinder 33, in the sheet conveyance direction, and serves as a drying device which irradiates the sheet S1 with light such as infrared or ultraviolet rays to dry ink printed on the sheet S1. Note that drying includes applying thermal energy to the ink to evaporate the moisture of the ink, and curing the ink.

The printing cylinder 33 is arranged on the downstream side of the inkjet nozzle portion 34 in the sheet conveyance direction to be in contact with a delivery-side transfer cylinder 36 rotatably supported on the frame 3a. The delivery-side transfer cylinder 36 has a gripper device 36a which holds the leading edge of the sheet S1, conveyed by the printing cylinder 33, upon receiving it from the printing cylinder gripper devices 33a, 33b, and 33c.

A delivery-side transfer cylinder 37 (fourth conveyance unit) serving as an upstream transport cylinder is arranged on the downstream side of the contact portion of the delivery-side transfer cylinder 36 with the printing cylinder 33 in the sheet conveyance direction to be in contact with the delivery-side transfer cylinder 36. The delivery-side transfer cylinder

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37 is rotatably supported on the frame 3a. The delivery-side transfer cylinder 37 has a gripper device 37a (upstream gripper device) which receives and holds the leading edge of the sheet S1 conveyed by the delivery-side transfer cylinder 36.

A delivery cylinder 38 is arranged on the downstream side of the contact portion of the delivery-side transfer cylinder 37 with the delivery-side transfer cylinder 36 in the sheet conveyance direction to be in contact with the delivery-side transfer cylinder 37. The delivery cylinder 38 is rotatably supported on the frame 3a. The delivery cylinder 38 has a gripper device 38a (downstream gripper device) which receives and holds the leading edge of the sheet S1 conveyed by the delivery-side transfer cylinder 37.

A belt conveyor-shaped delivery belt 40 which conveys the sheet S1 is disposed below the delivery cylinder 38. A pile board 41 which stacks sheets S1 having undergone a digital printing process by the digital printing unit 3 is provided on the leading edge side of the delivery belt 40 in the sheet conveyance direction. The delivery cylinder 38, delivery belt 40, and pile board 41 constitute the sheet delivery device 4. Also, the path of the sheet S1 conveyed by the delivery cylinder 38 and delivery belt 40 constitutes a sheet discharge path.

A pre-reversal double-diameter cylinder 39 (first conveyance unit) serving as a transport cylinder is arranged on the downstream side of the contact portion of the delivery-side transfer cylinder 37 with the delivery cylinder 38 in the sheet conveyance direction to be in contact with the delivery-side transfer cylinder 37. The pre-reversal double-diameter cylinder 39 is rotatably supported on the frame 3a. The pre-reversal double-diameter cylinder 39 includes a gripper device 39a (first holder) which is implemented by a double-diameter cylinder with a diameter twice that of the delivery-side transfer cylinder 37, and receives and holds the leading edge of the sheet S1 conveyed by the delivery-side transfer cylinder 37. The pre-reversal double-diameter cylinder 39 also includes a circumferential surface 39c (support surface) which supports the entire surface of the sheet S1 with its leading edge held by the gripper device 39a.

A reversing swing arm shaft pregripper 31b (third conveyance unit) having a reversing gripper device 31bt (third holder) which receives and holds the trailing edge (rear edge) of the sheet S1 as its other edge is opposed to the pre-reversal double-diameter cylinder 39 on the downstream side of the contact portion of the pre-reversal double-diameter cylinder 39 with the delivery-side transfer cylinder 37 in the sheet conveyance direction, as shown in FIG. 2.

A plurality of swing arms 202 are fixed to a reversing swing arm shaft 201 with predetermined gaps between them in the cylinder axis direction. The reversing swing arm shaft 201 is pivotally supported on the frame 3a. A swing arm gripper 203 is pivotally attached to the distal end of each of the plurality of swing arms 202 through a gripper shaft 203a.

A gripper pad 205 is provided at a position at which it is opposed to each swing arm gripper 203, and is attached to a gripper pad holding portion 204 fixed to the distal ends of the swing arms 202. A plurality of sets of swing arm grippers 203 and gripper pads 205 constitute the reversing gripper device 31bt which grips and holds the trailing edge of the sheet S1. The reversing gripper device 31bt, swing arms 202, reversing swing arm shaft 201, and gripper pad holding portion 204 constitute the reversing swing arm shaft pregripper 31b.

The reversing swing arm shaft pregripper 31b is supported to be swingable between a reception position (a broken line in FIG. 1), at which it receives the sheet S1 from the pre-reversal double-diameter cylinder 39, and a transfer position (a solid line in FIG. 1), at which it transfers by a gripping change the

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sheet S1 onto the printing cylinder 33, by pivoting the pivotal reversing swing arm shaft 201.

The reversing swing arm shaft pregripper 31b is opposed to the printing cylinder 33 on the downstream side of the contact portion of the printing cylinder 33 with the delivery-side transfer cylinder 36 in the rotation direction of the printing cylinder 33, and on the upstream side of the contact portion of the printing cylinder 33 with the feed-side transfer cylinder 32 in the rotation direction of the printing cylinder 33.

A plurality of groove-shaped recessed portions 39b are formed in the circumferential surface 39c of the pre-reversal double-diameter cylinder 39, pivotally supported on the frame 3a, with gaps between them in the axial direction to extend circumferentially, as shown in FIG. 3. The recessed portions 39b are opposed to the gripper device 37a of the delivery-side transfer cylinder 37, and the reversing gripper device 31bt of the reversing swing arm shaft pregripper 31b. The pre-reversal double-diameter cylinder 39 has a driving system independent of those of, for example, the printing cylinder 33, delivery-side transfer cylinder 37, and reversing swing arm shaft pregripper 31b, and is driven independently of the remaining cylinders by an independent driving motor 254 which independently drives it. Note that the pre-reversal double-diameter cylinder 39, reversing swing arm shaft pregripper 31b, and printing cylinder 33 constitute the sheet conveyance device.

The operation of the gripper device 37a of the delivery-side transfer cylinder 37 is controlled so as to selectively transfer the sheet S1 to the gripper device 38a of the delivery cylinder 38, and the gripper device 39a of the pre-reversal double-diameter cylinder 39. Also, the operation of the gripper device 38a of the delivery cylinder 38 is controlled so as to selectively receive the leading edge of the sheet S1 conveyed by the delivery-side transfer cylinder 37.

The delivery-side transfer cylinders 36 and 37, pre-reversal double-diameter cylinder 39, and reversing swing arm shaft pregripper 31b constitute a sheet reversing path used to turn and convey the sheet S1. The sheet reversing path is used to receive the sheet S1 from the printing cylinder 33, and turn and transfer the sheet S1 onto the printing cylinder 33.

The gripper device 37a of the delivery-side transfer cylinder 37, and the gripper device 38a of the delivery cylinder 38 constitute a sheet conveyance path switching device which selectively switches the path of the sheet S1 between the sheet reversing path and the sheet discharge path.

<Configuration of Control System for Digital Printing Apparatus>

The digital printing apparatus 1 includes a control unit 251 having a CPU (Central Processing Unit) configuration which controls the overall printing operation, as shown in FIG. 4. The control unit 251 is connected to a sheet size input unit 252 which receives the size of the sheet S1, a single-/double-sided printing mode input unit 253 (printing condition input unit) which selects a single- or double-sided printing mode, the independent driving motor 254 (independent driving unit) which independently drives the pre-reversal double-diameter cylinder 39, and a prime motor 255 (device driving unit) which drives the entire printing press. The prime motor 255 interlocks and drives the driving system for the printing press other than the pre-reversal double-diameter cylinder 39.

<Printing Operation of Digital Printing Apparatus>

The printing operation of the digital printing apparatus 1 configured as mentioned above will be described separately for the case wherein the single-sided printing mode is selected and that wherein the double-sided printing mode is selected.

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When the single-sided printing mode is selected by operating a printing mode selection switch **80** by the operator, the continuous supply valve **26** is actuated. With this operation, the suction ports **23a** and **23b** suck the sheet **S1** on the pile board **21**, and convey it onto the feeder board **FB**, as shown in FIG. **1**. When the single-sided printing mode is selected, the independent driving motor is controlled by the control unit **251** to stop the rotation of the pre-reversal double-diameter cylinder **39**. This suppresses wasteful power consumption to allow energy saving.

The continuous supply valve **26** opens every time the same number of sheets **S1** as the numbers of printing cylinder gripper devices **33a**, **33b**, and **33c** of the printing cylinder **33** are supplied during 360° rotation of the printing cylinder **33**, that is, at each timing (period) at which the printing cylinder gripper devices **33a**, **33b**, and **33c** in the printing cylinder **33**, and the gripper device **32a** of the feed-side transfer cylinder **32** are opposed to each other. As the continuous supply valve **26** opens, a negative pressure is supplied from the negative pressure source **25** to the suction ports **23a** and **23b** to perform suction. Supply of the sheets **S1** so that all the printing cylinder gripper devices **33a**, **33b**, and **33c** of the printing cylinder **33** grip the sheets **S1** will be referred to as continuous sheet feed hereinafter. Also, the period at which the continuous supply valve **26** opens/closes in continuous sheet feed will be referred to as a first period hereinafter. With this operation, the sucker device **23** conveys the sheets **S1** onto the feeder board **FB** at the first period.

The leading edge of the sheet **S1** conveyed by the feeder board **FB** is held by the gripper device of the swing arm shaft pregripper **31f**, and the sheet **S1** is conveyed onto the feed-side transfer cylinder **32** upon a swing of the swing arm shaft pregripper **31f**. The leading edge of the sheet **S1** conveyed onto the feed-side transfer cylinder **32** is transferred by a gripping change to the gripper device **32a** of the feed-side transfer cylinder **32**.

The leading edge of the sheet **S1** conveyed with rotation of the feed-side transfer cylinder **32** is transferred by a gripping change from the gripper device **32a** of the feed-side transfer cylinder **32** to one of the printing cylinder gripper devices **33a**, **33b**, and **33c** of the printing cylinder **33**, and the sheet **S1** is conveyed with rotation of the printing cylinder **33**. In the printing cylinder **33**, a suction force acts on suction holes **33g** on the downstream side in the rotation direction from a suction start position **33i**, so the entire surface of the sheet **S1** is sucked to and brought into tight contact with the support surfaces **33d**, **33e**, and **33f** as the sheet **S1** passes through the suction start position **33i**.

A digital printing process is performed on the obverse surface of the sheet **S1** conveyed by the printing cylinder **33** by discharging minute drops of ink from the ink heads **34a** to **34d** of the inkjet nozzle portion **34**. The sheet **S1** is in tight contact with the support surface of the printing cylinder **33**, and is therefore conveyed while minute intervals with the ink heads **34a** to **34d** are maintained. Ink discharged while these minute intervals are maintained can be adhered to the sheet **S1** with high accuracy, thereby allowing high-quality printing.

The ink on the sheet **S1** printed by the inkjet nozzle portion **34** dries with light emitted by the ink drying lamp **35** when the sheet **S1** passes between the printing cylinder **33** and the ink drying lamp **35**. The sheet **S1** is then conveyed onto the delivery-side transfer cylinder **36**.

In the contact portion between the printing cylinder **33** and the delivery-side transfer cylinder **36**, the leading edge of the sheet **S1** is transferred by a gripping change from the printing cylinder gripper devices **33a** to **33c** of the printing cylinder **33** to the gripper device **36a** of the delivery-side transfer cylinder

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36, as shown in FIG. **5A**. At this time, the leading edge of the sheet **S1** passes through a suction end position **33j**, so no suction force acts from the suction holes **33g**. This makes it possible to easily peel the sheet **S1** off the support surfaces **33d**, **33e**, and **33f** to allow a smooth gripping change. Then, the leading edge of the sheet **S1** held by the gripper device **36a** of the delivery-side transfer cylinder **36** is transferred by a gripping change from the gripper device **36a** of the delivery-side transfer cylinder **36** to the gripper device **37a** of the delivery-side transfer cylinder **37** in the contact portion between the delivery-side transfer cylinders **36** and **37**, as shown in FIG. **5B**.

In the single-sided printing mode, in the phase in which the leading edge of the sheet **S1** is positioned in the contact portion between the delivery-side transfer cylinders **37** and **38**, the gripper device **37a** of the delivery-side transfer cylinder **37** cancels holding of the leading edge of the sheet **S1**, and the gripper device **38a** of the delivery cylinder **38** grips and holds the leading edge of the sheet **S1** at the same time. With this operation, the sheet **S1** printed on its one surface is transferred from the delivery-side transfer cylinder **37** onto the delivery cylinder **38**, and conveyed.

Holding, by the gripper device **38a**, of the sheet **S1** transferred onto the delivery cylinder **38** is canceled at the timing at which the gripper device **38a** of the delivery cylinder **38** is positioned above the delivery belt **40**, and is placed on the delivery belt **40**.

The sheet **S1** placed on the delivery belt **40** is conveyed as the delivery belt **40** travels, and the sheet **S1** having undergone a digital printing process on its obverse surface is discharged onto the pile board **41** of the sheet delivery device **4**.

In the single-sided printing mode, all sheets **S1** are switched to the sheet discharge path, so no sheet **S1** is conveyed to either the pre-reversal double-diameter cylinder **39** or reversing swing arm shaft pregripper **31b**. Further, in the single-sided printing mode, the pre-reversal double-diameter cylinder **39** is kept stopped without rotation, and the delivery-side transfer cylinder **37** and reversing swing arm shaft pregripper **31b** provided on the upstream and downstream sides of the pre-reversal double-diameter cylinder **39** operate, but the recessed portions **39b** in the pre-reversal double-diameter cylinder **39** are opposed to the gripper device **37a** of the delivery-side transfer cylinder **37**, and the reversing gripper device **31bt** of the reversing swing arm shaft pregripper **31b**, so the gripper devices **37a** and **31bt** do not interfere with the pre-reversal double-diameter cylinder **39**.

On the other hand, when the double-sided printing mode is selected by an operation input to the single-/double-sided printing mode input unit **253**, the operator inputs the dimension of the sheet **S1** in the conveyance direction to the sheet size input unit **252**. When a printing operation starts, the control unit **251** actuates the intermittent supply valve **27** to make the suction ports **23a** and **23b** suck and convey the sheet **S1** on the pile board **21** onto the feeder board **FB**.

The intermittent supply valve **27** is controlled at the timing at which the sheets **S1** are alternately supplied so as to open, close, open, close, . . . , at the timing of continuous supply, that is, the timing at which the printing cylinder gripper devices **33a**, **33b**, and **33c** of the printing cylinder **33**, and the gripper device **32a** of the feed-side transfer cylinder **32** are opposed to each other. This period is twice that of continuous supply. In this manner, supply of the sheets **S1** so that the printing cylinder gripper devices **33a**, **33b**, and **33c** of the printing cylinder **33** alternately grip the sheets **S1** will be referred to as intermittent sheet feed hereinafter, and the period at which the intermittent supply valve **27** opens/closes in intermittent sheet feed will be referred to as a second period hereinafter.

With this operation, the sucker device **23** conveys the sheets **S1** onto the feeder board **FB** at the second period.

The sheet **S1** fed onto the feeder board **FB** by the sucker device **23** is transferred onto the printing cylinder **33** through the swing arm shaft pregripper **31f** and feed-side transfer cylinder **32** in the same way as in the single-sided printing mode. At this time, since the sheet **S1** is fed at the timing of intermittent sheet feed, the printing cylinder gripper devices **33a** to **33c** of the printing cylinder **33** receive the sheet **S1** alternately conveyed from the feed-side transfer cylinder **32**.

The sheet **S1** transferred onto the printing cylinder **33** is conveyed to the inkjet nozzle portion **34**, and obverse surface printing is performed on one surface (obverse surface). The control unit **251** prints on the sheet **S1** alternately held by the printing cylinder gripper devices **33a** to **33c** of the printing cylinder **33**, based on a phase signal from the rotary encoder **84**. On the other hand, the ink heads **34a** to **34d** of the inkjet nozzle portion **34** are controlled so as not to print on the support surfaces **33d** to **33f** corresponding to the printing cylinder gripper devices **33a** to **33c** which do not hold the sheet **S1**.

For double-sided printing, the control unit **251** controls the conveyance path switching device **82** so that the sheet **S1** printed on its obverse surface by the inkjet nozzle portion **34** is transferred onto the pre-reversal double-diameter cylinder **39** without transferring it from the delivery-side transfer cylinder **37** onto the delivery cylinder **38**.

More specifically, in conveyance path switching control, in the phase in which the sheet **S1** which is printed on its obverse surface and has undergone no digital print process on its other surface (reverse surface) is positioned in the contact portion between the delivery-side transfer cylinder **37** and the delivery cylinder **38**, the grippers of the gripper device **37a** of the delivery-side transfer cylinder **37** are kept closed without opening to maintain the state in which the gripper device **37a** holds the leading edge of the sheet **S1**. At this time, the grippers of the gripper device **38a** of the delivery cylinder **38** are kept open without closing. With this operation, the sheet **S1** printed only on its obverse surface continues to be conveyed by the delivery-side transfer cylinder **37** without a gripping change from the delivery-side transfer cylinder **37** to the delivery cylinder **38**.

The leading edge of the sheet **S1** conveyed by the delivery-side transfer cylinder **37** is held by closing the grippers of the gripper device **39a** of the pre-reversal double-diameter cylinder **39** in the contact portion between the delivery-side transfer cylinder **37** and the pre-reversal double-diameter cylinder **39**. At the same time, holding of the leading edge of the sheet **S1** is canceled by opening the grippers of the gripper device **37a** of the delivery-side transfer cylinder **37**. With this operation, the leading edge of the sheet **S1** is transferred by a gripping change from the gripper device **37a** of the delivery-side transfer cylinder **37** to the gripper device **39a** of the pre-reversal double-diameter cylinder **39**, as shown in FIG. 5C.

At this time, since the groove-shaped recessed portions **39b** (FIG. 3) are formed in the circumferential surface **39c** of the pre-reversal double-diameter cylinder **39** to be opposed to the gripper device **37a** of the delivery-side transfer cylinder **37**, the gripper device **37a** of the delivery-side transfer cylinder **37** passes through the grooves of the recessed portions **39b** to prevent the circumferential surface of the pre-reversal double-diameter cylinder **39** from suffering damage.

The sheet **S1** conveyed with rotation of the pre-reversal double-diameter cylinder **39** is conveyed with rotation of the pre-reversal double-diameter cylinder **39**, as shown in FIG. 5D. The reversing swing arm shaft pregripper **31b** swings

from a transfer position (solid line) to a reception position (broken line) to make the reversing gripper device **31bt** of the reversing swing arm shaft pregripper **31b** hold the trailing edge of the sheet **S1**, and holding of the leading edge of the sheet **S1** by the gripper device **39a** of the pre-reversal double-diameter cylinder **39** is canceled at the same time. With this operation, the sheet **S1** is transferred by a gripping change from the pre-reversal double-diameter cylinder **39** to the reversing swing arm shaft pregripper **31b**.

At this time, since the groove-shaped recessed portions **39b** (FIG. 3) are formed in the circumferential surface of the pre-reversal double-diameter cylinder **39** to be opposed to the reversing gripper device **31bt** of the reversing swing arm shaft pregripper **31b**, the reversing gripper device **31bt** of the reversing swing arm shaft pregripper **31b** passes through the grooves of the recessed portions **39b** to prevent the circumferential surface of the pre-reversal double-diameter cylinder **39** from suffering damage.

An operation in which the pre-reversal double-diameter cylinder **39** receives the sheet **S1** from the delivery-side transfer cylinder **37**, and transfers it to the reversing swing arm shaft pregripper **31b** (driving control of the pre-reversal double-diameter cylinder **39**) will be described in detail. If the dimension in the conveyance direction, which is input to the sheet size input unit **252**, is a standard size (middle-sized paper), the control unit **251** controls the independent driving motor **254** to rotate the pre-reversal double-diameter cylinder **39** at a reference speed. The reference speed means the rotation speed at which the pre-reversal double-diameter cylinder **39** rotates at a peripheral speed equal to those of the printing cylinder **33** and delivery-side transfer cylinder **37**. The pre-reversal double-diameter cylinder **39** rotates at the reference speed with no difference in peripheral speed between the printing cylinder **33** and the delivery-side transfer cylinder **37**.

The control operation of the rotation speed of the pre-reversal double-diameter cylinder **39** by the control unit **251** will be described with reference to FIG. 6. FIG. 6 shows the rotation speed of the pre-reversal double-diameter cylinder **39** when the digital printing apparatus **1** operates at a steady speed, that is, the printing cylinder **33** and delivery-side transfer cylinder **37** rotate at a constant speed. FIG. 6 shows the time or the phase of the digital printing apparatus **1** on the abscissa, and the rotation speed of the pre-reversal double-diameter cylinder **39** on the ordinate. Note that **t0** is the reception timing at which the leading edge of the sheet **S1** is transferred by a gripping change from the delivery-side transfer cylinder **37** to the pre-reversal double-diameter cylinder **39**, **t1** is the first adjustment start timing of the rotation speed of the pre-reversal double-diameter cylinder **39**, **t2** is the first adjustment end timing of the rotation speed of the pre-reversal double-diameter cylinder **39**, and **t3** is the transfer timing at which the trailing edge of the sheet **S1** is transferred by a gripping change from the pre-reversal double-diameter cylinder **39** to the reversing swing arm shaft pregripper **31b**. Also, **t4** is the second adjustment start timing of the rotation speed of the pre-reversal double-diameter cylinder **39**, **t5** is the second adjustment end timing of the rotation speed of the pre-reversal double-diameter cylinder **39**, and **t6** is the reception timing at which the leading edge of the sheet **S1** is transferred by a gripping change from the delivery-side transfer cylinder **37** to the pre-reversal double-diameter cylinder **39** again.

Note that the above-mentioned timings **t0** to **t6** indicate the times or the phases of the digital printing apparatus **1**, and reception timings **t6** and **t0** are identical when the timing is represented as a phase. Also, the interval from first adjustment

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start timing **t1** to first adjustment end timing **t2** is defined as a first speed adjustment region, and that from second adjustment start timing **t4** to second adjustment end timing **t5** is defined as a second speed adjustment region.

If the dimension of the sheet **S1** in the conveyance direction is a standard size (middle-sized paper), when the digital printing apparatus **1** operates at a steady speed, the pre-reversal double-diameter cylinder **39** is rotated by the independent driving motor **254** at a constant speed **v0** (reference speed) with no change in speed from reception timing **t0** to reception timing **t6**, as indicated by bold lines in FIG. 6. The pre-reversal double-diameter cylinder **39** must be rotated at a peripheral speed equal to those of the printing cylinder **33** and delivery-side transfer cylinder **37**. Hence, when the digital printing apparatus **1** operates at a steady speed, the printing cylinder **33** and delivery-side transfer cylinder **37** are driven by the prime motor **255**, while the pre-reversal double-diameter cylinder **39** is rotated at a constant speed **v0** by the independent driving motor **254**. However, when the digital printing apparatus **1** does not operate at a steady speed, the pre-reversal double-diameter cylinder **39** is rotated by the independent driving motor **254** at a peripheral speed which is equal to those of the printing cylinder **33** and delivery-side transfer cylinder **37** and different from the reference speed.

Upon this operation, at reception timing **t0**, the gripper device **37a** of the delivery-side transfer cylinder **37**, and the gripper device **39a** of the pre-reversal double-diameter cylinder **39** are opposed to each other, so the leading edge of a sheet **S1** with the standard size is transferred by a gripping change, and the sheet **S1** is wound around the circumferential surface **39c** of the pre-reversal double-diameter cylinder **39** and conveyed, as shown in FIG. 2.

At transfer timing **t3**, the trailing edge of the sheet **S1** which has the standard size and is conveyed by the pre-reversal double-diameter cylinder **39** rotated at the constant speed **v0** is opposed to the reversing gripper device **31bt** of the reversing swing arm shaft pregripper **31b** at a predetermined period at which the reversing swing arm shaft pregripper **31b** is set at the reception position, as shown in FIG. 7.

As the reversing gripper device **31bt** of the reversing swing arm shaft pregripper **31b** grips the trailing edge of the sheet **S1**, and the gripper device **39a** of the pre-reversal double-diameter cylinder **39** cancels holding of the leading edge of the sheet **S1**, the sheet **S1** is transferred by a gripping change from the pre-reversal double-diameter cylinder **39** to the reversing swing arm shaft pregripper **31b**. The reversing swing arm shaft pregripper **31b** then swings from the reception position to the transfer position, and transfers the turned sheet **S1** onto the printing cylinder **33**, as shown in FIG. 8.

As described above, if the sheet **S1** has the standard size, the control unit **251** controls the pre-reversal double-diameter cylinder **39** to simply rotate at the reference speed through the independent driving motor **254**, so no change in speed with respect to the reference speed occurs.

Control if the dimension of the sheet **S1** in the conveyance direction is larger than the standard size, as shown in FIG. 8, will be described next. The case of a sheet **S1a** (maximum-sized paper) with a maximum dimension in the conveyance direction, that the digital printing apparatus **1** can print, will be explained. At reception timing **t0**, transfer timing **t3**, and reception timing **t6**, the control unit **251** rotates the pre-reversal double-diameter cylinder **39** at a reference speed (speed **v0**) equal to that in the case of the sheet **S1** with the standard size (middle-sized paper), as indicated by solid lines in FIG. 6. On the other hand, in the first speed adjustment region, the speed of the pre-reversal double-diameter cylinder **39** is controlled to gradually increase with respect to the

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reference speed from first adjustment start timing **t1**, and return to the reference speed at first adjustment end timing **t2**. Then, in the second speed adjustment region, the speed of the pre-reversal double-diameter cylinder **39** is controlled to gradually decrease with respect to the reference speed from second adjustment start timing **t4**, and return to the reference speed at second adjustment end timing **t5**. Note that the control unit **251** rotates the pre-reversal double-diameter cylinder **39** at the reference speed (speed **v0**) in the interval from reception timing **t0** to first adjustment start timing **t1**, that from first adjustment end timing **t2** to second adjustment start timing **t4**, and that from second adjustment end timing **t5** to reception timing **t6**.

In this case, at reception timing **t0** and transfer timing **t3**, the pre-reversal double-diameter cylinder **39** receives the sheet **S1a** from the delivery-side transfer cylinder **37** and transfers it to the reversing swing arm shaft pregripper **31b** while rotating at the reference speed. This allows a reliable gripping change of the sheet **S1a**.

Normally, when maximum-sized paper with a large size is transferred by a gripping change from the pre-reversal double-diameter cylinder **39** to the reversing swing arm shaft pregripper **31b**, the gripper device **39a** of the pre-reversal double-diameter cylinder **39** is set at a position, indicated by a broken line in FIG. 8, at transfer timing **t3** as the pre-reversal double-diameter cylinder **39** rotates while its rotation speed is kept at the constant speed **v0** (reference speed). In this case, the trailing edge of the sheet **S1a** has not yet reached the reversing gripper device **31bt** of the reversing swing arm shaft pregripper **31b** set at the reception position, and therefore cannot be gripped by the reversing gripper device **31bt**.

However, in the arrangement of this embodiment, in the first speed adjustment region, the pre-reversal double-diameter cylinder **39** is accelerated from the reference speed to advance the phase of the pre-reversal double-diameter cylinder **39** more than that of the digital printing apparatus **1**, thereby setting the gripper device **39a** of the pre-reversal double-diameter cylinder **39** at a position, indicated by a solid line in FIG. 8, at transfer timing **t3**. Upon this operation, the trailing edge of the sheet **S1a** is opposed to the reversing gripper device **31bt** of the reversing swing arm shaft pregripper **31b** set at the reception position.

By controlling the speed of the pre-reversal double-diameter cylinder **39** in this way, the trailing edge of the sheet **S1a** is gripped by the reversing gripper device **31bt** of the reversing swing arm shaft pregripper **31b**, and holding of the leading edge of the sheet **S1a** is canceled by the gripper device **39a** of the pre-reversal double-diameter cylinder **39** at the same time. With this operation, the sheet **S1a** is transferred by a gripping change from the pre-reversal double-diameter cylinder **39** to the reversing swing arm shaft pregripper **31b**. The reversing swing arm shaft pregripper **31b** then swings from the reception position to the transfer position, and transfers the turned sheet **S1a** onto the printing cylinder **33**, as shown in FIG. 5E.

After the trailing edge of the sheet **S1a** (maximum-sized paper) is transferred by a gripping change from the pre-reversal double-diameter cylinder **39** to the reversing swing arm shaft pregripper **31b** at transfer timing **t3**, the control unit **251** rotates the pre-reversal double-diameter cylinder **39** at the speed **v0** (reference speed). Then, in the second speed adjustment region, the pre-reversal double-diameter cylinder **39** is decelerated from the reference speed to retard the phase of the pre-reversal double-diameter cylinder **39**, which has advanced more than that of the digital printing apparatus **1**. Upon such phase control, at reception timing **t6**, the gripper device **39a** of the pre-reversal double-diameter cylinder **39** is

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opposed to the gripper device **37a** of the delivery-side transfer cylinder **37**, as shown in FIG. 2. With this operation, the leading edge of the sheet **S1a** is transferred by a gripping change from the gripper device **37a** of the delivery-side transfer cylinder **37** to the gripper device **39a** of the pre-reversal double-diameter cylinder **39**.

With this arrangement, the control unit **251** increases/decreases the rotation speed of the pre-reversal double-diameter cylinder **39** to control (adjust) the phase of the pre-reversal double-diameter cylinder **39** relative to that of the digital printing apparatus **1** in the first and second speed adjustment regions, that do not influence reception timing **t0**, transfer timing **t3**, and reception timing **t6** at which a gripping change of the sheet **S1a** (maximum-sized paper) is done.

As described above, even if a sheet **S1a** with a dimension in the conveyance direction, which is larger than the standard size, is used, the leading edge of the sheet **S1a** can reliably be transferred by a gripping change from the delivery-side transfer cylinder **37** to the pre-reversal double-diameter cylinder **39** by increasing/decreasing the rotation speed of the pre-reversal double-diameter cylinder **39**. Also, the trailing edge of the sheet **S1a** can reliably be transferred by a gripping change from the pre-reversal double-diameter cylinder **39** to the reversing swing arm shaft pregripper **31b**.

The case wherein the dimension of the sheet **S1** in the conveyance direction is smaller than the standard size, as shown in FIG. 9, will be described next. The case of a sheet **S1b** (minimum-sized paper) with a minimum dimension in the conveyance direction, that the digital printing apparatus **1** can print, will be explained. At reception timing **t0**, transfer timing **t3**, and reception timing **t6**, the control unit **251** rotates the pre-reversal double-diameter cylinder **39** at a reference speed (speed **v0**) equal to that in the case of the sheet **S1** with the standard size (middle-sized paper), as indicated by broken lines in FIG. 6. On the other hand, in the first speed adjustment region, the speed of the pre-reversal double-diameter cylinder **39** is controlled to gradually decrease with respect to the reference speed from first adjustment start timing **t1**, and return to the reference speed at first adjustment end timing **t2**. Then, in the second speed adjustment region, the speed of the pre-reversal double-diameter cylinder **39** is controlled to gradually increase with respect to the reference speed from second adjustment start timing **t4**, and return to the reference speed at second adjustment end timing **t5**. Note that the control unit **251** rotates the pre-reversal double-diameter cylinder **39** at the reference speed (speed **v0**) in the interval from reception timing **t0** to first adjustment start timing **t1**, that from first adjustment end timing **t2** to second adjustment start timing **t4**, and that from second adjustment end timing **t5** to reception timing **t6**.

In this case, at reception timing **t0** and transfer timing **t3**, the pre-reversal double-diameter cylinder **39** performs reception and transfer operations while rotating at the reference speed, thus allowing a reliable gripping change of the sheet **S1b**.

Normally, when minimum-sized paper with a small size is transferred by a gripping change from the pre-reversal double-diameter cylinder **39** to the reversing swing arm shaft pregripper **31b**, the gripper device **39a** of the pre-reversal double-diameter cylinder **39** is set at a position, indicated by a broken line in FIG. 9, at transfer timing **t3** as the pre-reversal double-diameter cylinder **39** rotates while its rotation speed is kept at the constant speed **v0** (reference speed). In this case, the trailing edge of the sheet **S1b** has already passed through the reversing gripper device **31bt** of the reversing swing arm shaft pregripper **31b** set at the reception position, and therefore cannot be gripped by the swing arm gripper **203**.

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However, in the arrangement of this embodiment, in the first speed adjustment region, the pre-reversal double-diameter cylinder **39** is decelerated from the reference speed to retard the phase of the pre-reversal double-diameter cylinder **39** more than that of the digital printing apparatus **1**, thereby setting the gripper device **39a** of the pre-reversal double-diameter cylinder **39** at a position, indicated by a solid line in FIG. 9, at transfer timing **t3**. Upon this operation, the trailing edge of the sheet **S1b** is opposed to the reversing gripper device **31bt** of the reversing swing arm shaft pregripper **31b** set at the reception position.

By controlling the speed of the pre-reversal double-diameter cylinder **39** in this way, the trailing edge of the sheet **S1b** is gripped by the reversing gripper device **31bt** of the reversing swing arm shaft pregripper **31b**, and holding of the leading edge of the sheet **S1b** is canceled by the gripper device **39a** of the pre-reversal double-diameter cylinder **39** at the same time. With this operation, the sheet **S1b** is transferred by a gripping change from the pre-reversal double-diameter cylinder **39** to the reversing swing arm shaft pregripper **31b**. The reversing swing arm shaft pregripper **31b** then swings from the reception position to the transfer position, and transfers the turned sheet **S1b** onto the printing cylinder **33**, as shown in FIG. 5E.

After the trailing edge of the sheet **S1a** (minimum-sized paper) is transferred by a gripping change from the pre-reversal double-diameter cylinder **39** to the reversing swing arm shaft pregripper **31b** at transfer timing **t3**, the control unit **251** rotates the pre-reversal double-diameter cylinder **39** at the speed **v0** (reference speed). Then, in the second speed adjustment region, the pre-reversal double-diameter cylinder **39** is accelerated from the reference speed to advance the phase of the pre-reversal double-diameter cylinder **39**, which has retarded more than that of the digital printing apparatus **1**. Upon such phase control, at reception timing **t6**, the gripper device **39a** of the pre-reversal double-diameter cylinder **39** is opposed to the gripper device **37a** of the delivery-side transfer cylinder **37**, as shown in FIG. 2. With this operation, the leading edge of the sheet **S1b** is transferred by a gripping change from the gripper device **37a** of the delivery-side transfer cylinder **37** to the gripper device **39a** of the pre-reversal double-diameter cylinder **39**.

With this arrangement, the control unit **251** increases/decreases the rotation speed of the pre-reversal double-diameter cylinder **39** to control (adjust) the phase of the pre-reversal double-diameter cylinder **39** relative to that of the digital printing apparatus **1** in the first and second speed adjustment regions, that do not influence reception timing **t0**, transfer timing **t3**, and reception timing **t6** at which a gripping change of the sheet **S1b** (minimum-sized paper) is done.

As described above, even if a sheet **S1b** with a dimension in the conveyance direction, which is smaller than the standard size, is used, the leading edge of the sheet **S1b** can reliably be transferred by a gripping change from the delivery-side transfer cylinder **37** to the pre-reversal double-diameter cylinder **39** by increasing/decreasing the rotation speed of the pre-reversal double-diameter cylinder **39**. Also, the trailing edge of the sheet **S1b** can reliably be transferred by a gripping change from the pre-reversal double-diameter cylinder **39** to the reversing swing arm shaft pregripper **31b**.

Then, as shown in FIG. 10, as the reversing swing arm shaft pregripper **31b** swings from a reception position indicated by a broken line to a transfer position indicated by a solid line, the sheet **S1** (sheet **S1**, **S1a**, or **S1b**) with its trailing edge leading is conveyed onto the printing cylinder **33**. At this time, the trailing edge of the turned sheet **S1** is transferred by a

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gripping change from the reversing gripper device **31bt** of the reversing swing arm shaft pregrripper **31b** to one of the gripper devices **33a** to **33c**.

The gripper devices **33a** to **33c** of the printing cylinder **33** alternately hold a new sheet **S1** conveyed from the feed-side transfer cylinder **32**. The reversing swing arm shaft pregrripper **31b** is positioned at the transfer position at the timing at which it is opposed to the printing cylinder gripper devices **33a** to **33c** which hold no new sheet **S1**, and the trailing edge of the sheet **S1** is transferred from the reversing gripper device **31bt** to the printing cylinder gripper devices **33a** to **33c**. With this operation, a new sheet **S1** transferred from the feed-side transfer cylinder **32**, and a turned sheet **S1** transferred from the reversing gripper device **31bt** of the reversing swing arm shaft pregrripper **31b** are alternately held by the printing cylinder gripper devices **33a** to **33c** of the printing cylinder **33**, and are conveyed to the inkjet nozzle portion **34**.

The trailing edge of the turned sheet **S1** transferred from the reversing gripper device **31bt** of the reversing swing arm shaft pregrripper **31b** is held and conveyed by the gripper devices **33a** to **33c** of the printing cylinder **33** while the surface (the obverse surface having undergone a digital printing process) of the sheet **S1**, which has already undergone a digital printing process by the inkjet nozzle portion **34**, is in contact with the support surfaces **33d**, **33e**, and **33f** of the printing cylinder **33**, and the surface (the reverse surface having undergone no digital printing process) of the sheet **S1**, which has not yet undergone a digital printing process, is exposed. The inkjet nozzle portion **34** performs a digital printing process on the reverse surface of the sheet **S1** conveyed in tight contact with the circumferential surface of the printing cylinder **33** in a turned state.

The control unit **251** controls the inkjet nozzle heads **34a** to **34d** of the inkjet nozzle portion **34** to perform reverse printing on the turned sheet **S1** transferred from the reversing gripper device **31bt** of the reversing swing arm shaft pregrripper **31b**, and perform obverse printing on the new sheet **S1** alternately held by the printing cylinder gripper devices **33a** to **33c** of the printing cylinder **33**. With this operation, the inkjet nozzle heads **34a** to **34d** alternately perform obverse printing and reverse printing in correspondence with the new sheet **S1** and turned sheet **S1** alternately held by the printing cylinder **33**.

The sheet **S1** having undergone reverse printing on its reverse surface is discharged from the delivery belt **40** onto the pile board **41** sequentially through the delivery-side transfer cylinders **36** and **37**, and delivery cylinder **38**, as in the single-sided printing mode.

According to this embodiment, even if a sheet **S1a** or **S1b** with a dimension in the sheet conveyance direction, which is larger or smaller than that of the standard size (middle-sized paper), is used, the independent driving motor **254** is controlled to increase/decrease (adjust) the rotation speed of the pre-reversal double-diameter cylinder **39** based on the dimension in the sheet conveyance direction. It is therefore possible to reliably receive the leading edge of the sheet **S1** from the delivery-side transfer cylinder **37** to the pre-reversal double-diameter cylinder **39**, and transfer the trailing edge of the sheet **S1** from the pre-reversal double-diameter cylinder **39** to the reversing swing arm shaft pregrripper **31b**. This obviates the need for mechanical adjustment that accompanies a change in sheet size to relieve the operator's burden. This also obviates the need for a preparatory operation to improve the productivity.

Also, the sheet **S1** is sequentially transferred to the feed-side transfer cylinder **32**, printing cylinder **33**, delivery-side transfer cylinders **36** and **37**, pre-reversal double-diameter cylinder **39**, and reversing swing arm shaft pregrripper **31b** by

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a gripping change by the gripper devices. This makes it possible to obtain high registration accuracy and high obverse/reverse registration accuracy of the obverse and reverse surfaces of the sheet **S1** in the conveyance direction or widthwise direction of the sheet **S1**, thus improving the printing quality of the sheet **S1**.

(2) Second Embodiment

The second embodiment is the same as the first embodiment except for the configuration of the control block of the digital printing apparatus **1**. Only a control block of a digital printing apparatus **200** according to the second embodiment will be described below.

<Configuration of Control System for Digital Printing Apparatus>

The digital printing apparatus **200** includes a control unit **351** having a CPU configuration which controls the overall printing operation, as shown in FIG. **10**. The control unit **351** is connected to a sheet size input unit **252** which receives the sheet size as standard information, a sheet size error detection unit **255** which includes a photoelectric sensor arranged near a printing cylinder **33**, a single-/double-sided printing mode input unit **253** which selects a single- or double-sided printing mode, an independent driving motor **254**, and a prime motor **255**. The sheet size error detection unit **255** detects an error of the sheet size, that is, the dimension in the conveyance direction, which is actually printed for standard data input via the sheet size input unit **252**.

The control unit **351** receives signals output from the sheet size input unit **252**, sheet size error detection unit **255**, and single-/double-sided printing mode input unit **253** to control the independent driving motor **254**. Differences from the first embodiment lie in that the sheet size input unit **252** receives the sheet size as standard information, and the sheet size error detection unit **255** is provided.

<Operation of Adjusting Rotation Speed of Pre-Reversal Double-Diameter Cylinder>

The control unit **351** recognizes the sheet **S1** as one of a sheet **S1** with a standard size (middle-sized paper), a sheet **S1a** (maximum-sized paper) with a large dimension in the conveyance direction, and a sheet **S1b** (minimum-sized paper) with a small dimension in the conveyance direction, based on the standard information (middle-sized paper, maximum-sized paper, or minimum-sized paper) of the sheet **S1** input to the sheet size input unit **252**.

The sheet size error detection unit **255** detects errors of the sheet sizes (sheet conveyance direction) for three types of standard information for the first sheet **S1** (middle-sized paper), sheet **S1a** (maximum-sized paper), or sheet **S1b** (minimum-sized paper) supplied for each lot, and sends these errors to the control unit **351**. The control unit **351** adds/subtracts one (error data corresponding to input standard information) of three types of error data input from the sheet size error detection unit **255** to/from standard information (one of middle-sized paper, maximum-sized paper, and minimum-sized paper), and determines the actual size of the sheet. The control unit **351** controls driving of the independent driving motor **254** to increase/decrease the rotation speed of a pre-reversal double-diameter cylinder **39** based on the obtained actual size of the sheet.

With this operation, the leading edge of the sheet **S1a** from a delivery-side transfer cylinder **37** can reliably be received by a gripping change by the pre-reversal double-diameter cylinder **39**, regardless of the sheet size. Also, the trailing edge of the sheet **S1a** can reliably be transferred by a gripping

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change from the pre-reversal double-diameter cylinder **39** to a reversing swing arm shaft pregripper **31b**.

Note that by sending, in advance, standard information input from the control unit **351** to the sheet size input unit **252**, the sheet size error detection unit **255** may detect only error information for the sent standard information and output it to the control unit **351**.

(3) Third Embodiment

Only a control block of a digital printing apparatus **300** according to the third embodiment will be described below.
<Configuration of Control System for Digital Printing Apparatus>

The digital printing apparatus **300** includes a control unit **451** having a CPU configuration which controls the overall printing operation, as shown in FIG. 11. The control unit **451** is connected to a sheet size detection unit **257** arranged near a printing cylinder **33**, a single-/double-sided printing mode input unit **253** which selects a single- or double-sided printing mode, an independent driving motor **254**, and a prime motor **255**. The sheet size detection unit **257** detects the dimension in the conveyance direction (size). A difference from the first embodiment lies in that the sheet size detection unit **257** is provided in place of the sheet size input unit **257**.

<Operation of Adjusting Rotation Speed of Pre-Reversal Double-diameter Cylinder>

The sheet size detection unit **257** detects the dimension, in the conveyance direction, of a sheet **S1** conveyed by a pre-reversal double-diameter cylinder **39**, and outputs it to the control unit **451**. The control unit **451** recognizes the dimension of each sheet **S1** in the conveyance direction based on the output from the sheet size detection unit **257**. The control unit **451** controls the independent driving motor **254** to increase/decrease the rotation speed of the pre-reversal double-diameter cylinder **39** based on the measurement data of the sheet **S1** detected by the sheet size detection unit **257**, that is, the actual size of the sheet **S1**. With this operation, the leading edge of the sheet **S1** from a delivery-side transfer cylinder **37** can reliably be received by a gripping change by the pre-reversal double-diameter cylinder **39**, regardless of the sheet size. Also, the trailing edge of the sheet **S1** can reliably be transferred by a gripping change from the pre-reversal double-diameter cylinder **39** to a reversing swing arm shaft pregripper **31b**.

(4) Other Embodiments

Although a sheet conveyance device is applied to the digital printing apparatus **1** (sheet processing apparatus) in the above-mentioned embodiment, the present invention is not limited to this. The sheet conveyance device according to the present invention may also be applied to, for example, an offset print process apparatus, inspection process apparatus, foil transfer process apparatus, and embossing process apparatus as other sheet processing apparatuses.

Also, assuming that a sheet **S1** (middle-sized paper) has a standard size, the rotation speed of the pre-reversal double-diameter cylinder **39** is increased/decreased when sheets **S1a** and **S1b** with sizes in the sheet conveyance direction, which are larger and smaller than the standard size, are conveyed. The present invention is not limited to this, and assuming that a sheet **S1a** with a maximum dimension in the conveyance direction has a standard size, the rotation speed of the pre-reversal double-diameter cylinder **39** may be adjusted when a sheet with a dimension in the sheet conveyance direction, which is smaller than the standard size, is conveyed. Also,

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assuming that a sheet **S1b** with a minimum dimension in the conveyance direction has a standard size, the rotation speed of the pre-reversal double-diameter cylinder **39** may be adjusted when a sheet with a dimension in the sheet conveyance direction, which is larger than the standard size, is conveyed.

Moreover, although the printing cylinder **33** implemented by a triple-diameter cylinder is used in the above-mentioned embodiments, the present invention is not limited to this, and a printing cylinder implemented by a double-, quadrupole- or sextuple-diameter cylinder may be used.

What is claimed is:

1. A sheet conveyance device comprising:

a first conveyance unit which includes a first holder that holds a leading edge of a sheet with respect to a conveyance direction, and conveys the sheet held by said first holder;

a second conveyance unit which includes a second holder that holds a leading edge of the sheet with respect to a conveyance direction, and conveys the sheet held by said second holder;

a third conveyance unit which is supported to be swingable between a reception position at which said third conveyance unit receives the sheet from said first conveyance unit, and a transfer position at which said third conveyance unit transfers the sheet to said second conveyance unit, said third conveyance unit including a third holder that holds a trailing edge of the sheet with respect to the conveyance direction while the sheet is being conveyed by said first conveyance unit, and said third conveyance unit configured to receive by said third holder the trailing edge of the sheet conveyed by said first conveyance unit, to rotate in a first direction directed from the reception position to the transfer position, to transfer the received trailing edge of the sheet to said second holder of said second conveyance unit by a gripping change, and to rotate in a second direction opposite to the first direction; an independent driving unit which independently drives said first conveyance unit;

a device driving unit which drives an entire device including said second conveyance unit and said third conveyance unit; and

a control unit which controls said independent driving unit to adjust a speed at which said first conveyance unit conveys the sheet, based on a dimension of the sheet in a conveyance direction.

2. A device according to claim 1, wherein

said first conveyance unit includes a rotatably supported transport cylinder, and

said independent driving unit includes an independent driving motor which drives said transport cylinder independently of a device driving system.

3. A device according to claim 2, further comprising:

a fourth conveyance unit which is arranged on an upstream side of said transport cylinder in a sheet conveyance direction, includes a fourth holder that holds a leading edge of the sheet with respect to a conveyance direction, and transfers the sheet held by said fourth holder to said first holder of said transport cylinder,

wherein said control unit controls said independent driving motor to adjust a rotation speed of said transport cylinder in accordance with the dimension of the sheet in the conveyance direction so that

the trailing edge of the sheet conveyed by said transport cylinder is opposed to said third holder when said third conveyance unit is set at the sheet reception position, and

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said fourth holder of said fourth conveyance unit is opposed to said first holder of said first conveyance unit after the sheet is transferred to said third holder.

4. A device according to claim 3, wherein

if the dimension of the sheet in the conveyance direction is larger than a reference size, said control unit controls said independent driving motor to set the rotation speed of said transport cylinder higher than a reference speed after the sheet is received from said fourth conveyance unit, and then set the rotation speed of said transport cylinder lower than the reference speed after the sheet is transferred from said transport cylinder to said third conveyance unit, and

if the dimension of the sheet in the conveyance direction is smaller than the reference size, said control unit controls said independent driving motor to set the rotation speed of said transport cylinder lower than the reference speed after the sheet is received from said fourth conveyance unit, and then set the rotation speed of said transport cylinder higher than the reference speed after the sheet is transferred from said transport cylinder to said third conveyance unit.

5. A device according to claim 3, wherein

said control unit controls said independent driving motor to set the rotation speed of said transport cylinder to a reference speed when the sheet is transferred from said transport cylinder to said third conveyance unit, and the

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sheet is transferred from said fourth conveyance unit onto said transport cylinder.

6. A device according to claim 3, wherein

if the dimension of the sheet in the conveyance direction is a reference size, said control unit controls said independent driving motor to rotate said transport cylinder at a reference speed.

7. A device according to claim 1, further comprising a sheet size input unit to which a dimension of the sheet in the conveyance direction is input, wherein said control unit controls said independent driving unit based on the dimension of the sheet in the conveyance direction output from said sheet size input unit.

8. A device according to claim 7, further comprising an error detection unit which detects an error of a difference between the dimension of the sheet conveyed from said second unit to said third conveyance unit in the conveyance direction and standard information of the dimension of the sheet in the conveyance direction and outputs error information, wherein

standard information of the dimension of the sheet in the conveyance direction is input to said sheet size input unit, and

said control unit controls said independent driving unit based on the standard information output from said sheet size input unit and the error information output from said error detection unit.

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